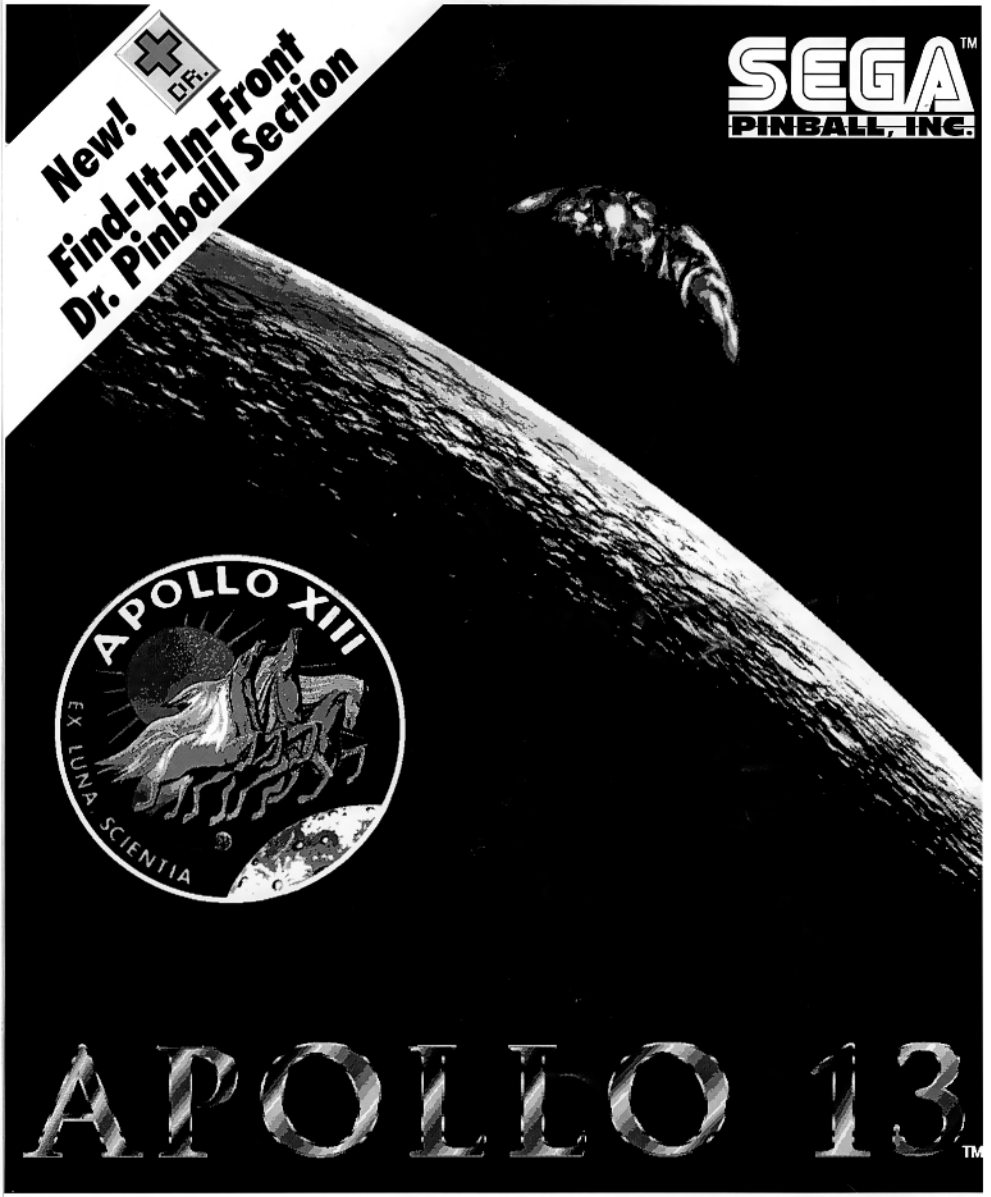

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☆ NEW ☆ FIND-IT-IN-FRONT: DR. PINBALL SECTION ☆ NEW ☆

The key technical data from various parts of the manual was extracted and combined into the "Find-It-In-Front: Dr. Pinball Section". This new section will assist the technician in locating important technical information needed to troubleshoot the machine.

We are introducing in our **Portals™ Service Menu** a new icon and diagnostic aid called Dr. Pinball (Flow Chart Menu). This is a feature that will allow the operator/technician to utilize the power of the microprocessor assisting in troubleshooting a problem with the machine.

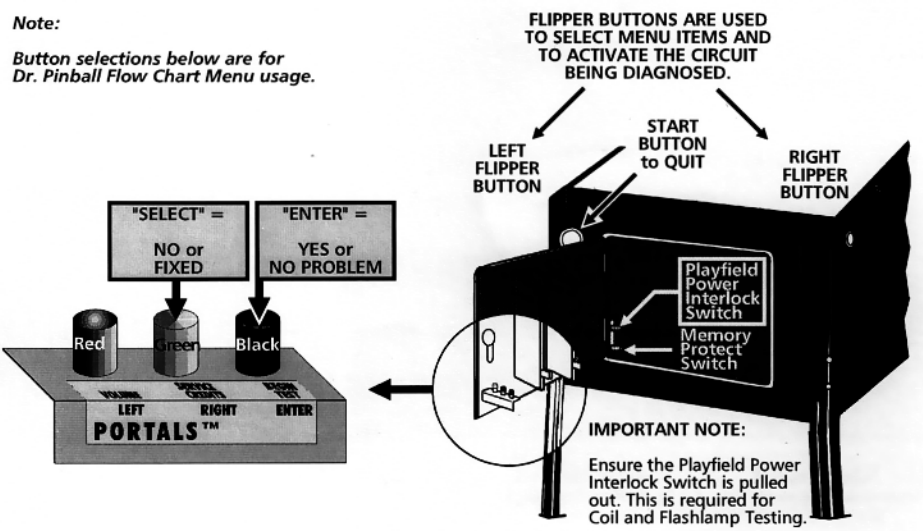
☆ ☆ ☆ ☆ HOW IT WORKS ☆ ☆ ☆ ☆

First, the operator/technician must enter the Service Mode (for a complete description of the **Portals™ Service Menu** and **ICONS** see Section 3, Chapter 1). To get into the Service Menu Mode: • Power-up game (if not already) & open the Coin Door. • On the Coin Door is the Service Switch Set (**Red, Green & Black Buttons**). Push down the **Black "BEGIN TEST" Button**. Looking at the Video Display you will momentarily see the introductory screen "Service Menu" with a satellite flying from right to left pulling a banner "Portals™ © 1995 SEGA PINBALL, INC.", followed by the **MAIN MENU**.

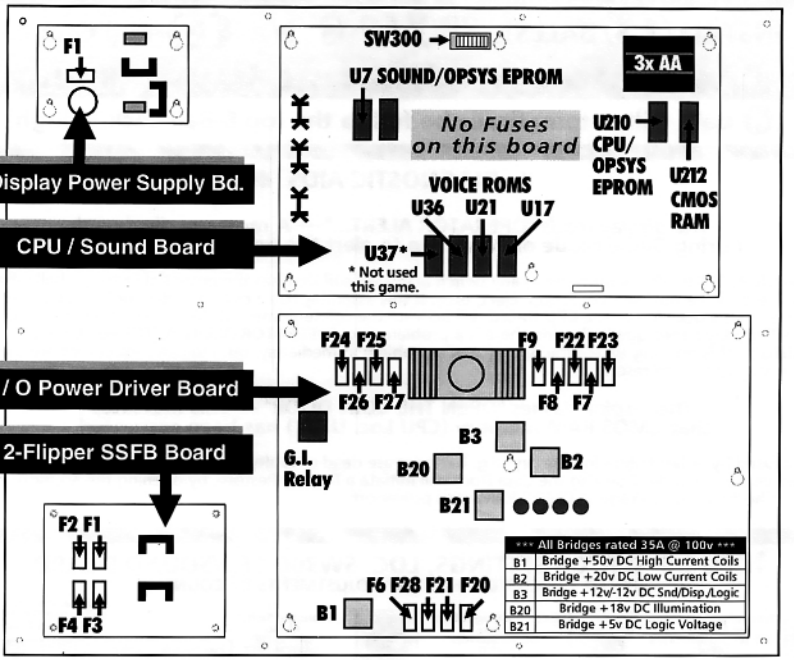
While in the **MAIN MENU**, select the "DIAG" *Icon*, then select the "DR" *Icon*. This will bring the operator/technician into the **FLOW CHART MENU** which offers the operator/technician a choice of four sub-menus: Flipper, Coil, Switch and Lamp. Selecting a particular sub-menu will give the operator/technician a choice of which specific lamp, switch or coil circuit needs to be diagnosed. The display will now ask a question or give a procedure to follow such as "Does the lamp turn on?" or "Check bridge rectifier BR-20, if short replace". When Dr. Pinball asks a question or request a procedure the Dr. will expect a response such as "YES, NO, FIXED or NO PROBLEM" (see figure below) which you the operator/technician must input by using the **Green "SELECT" (RIGHT)** and/or **Black "ENTER" Buttons** on the coin door. The **Flipper Buttons** can be used to activate the particular circuit being diagnosed and in the **MAIN MENU** to select a menu item. The **Start Button** will allow the operator/technician to quit at anytime.

Note:

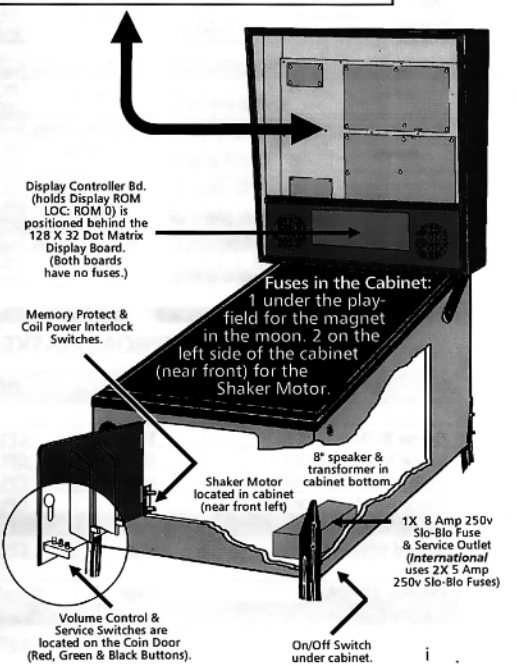
Button selections below are for Dr. Pinball Flow Chart Menu usage.


FLIPPER BUTTONS ARE USED TO SELECT MENU ITEMS AND TO ACTIVATE THE CIRCUIT BEING DIAGNOSED.
START BUTTON to QUIT
LEFT FLIPPER BUTTON
RIGHT FLIPPER BUTTON
"SELECT" = NO or FIXED
"ENTER" = YES or NO PROBLEM
Red
Green
Black
LEFT
RIGHT
ENTER
PORTALS™
Playfield Power Interlock Switch
Memory Protect Switch
IMPORTANT NOTE:
Ensure the Playfield Power Interlock Switch is pulled out. This is required for Coil and Flashlamp Testing.

NEW BACKBOX LAYOUT, FUSE & RELAY LOCATIONS



QUICK REFERENCE FUSE CHART	
Backbox Fuses DISPLAY POWER SUPPLY BOARD	
F1	3/4A 250v Slo-Blo 90v DC High Voltage Display
2-FLIPPER SSFB BOARD	
F1	3A 250v Slo-Blo 50v DC Output (all fuses) Lower Right Flipper
F2	3A 250v Slo-Blo 9v AC Holding
F3	3A 250v Slo-Blo 50v DC Output Lower Left Flipper
F4	3A 250v Slo-Blo 9v AC Holding
I / O POWER DRIVER BOARD	
F6	7A 250v Slo-Blo 50v DC Primary High Power Coils & Flippers
F7	5A 250v Slo-Blo 20v DC Low Power Coils
F8	5A 250v Slo-Blo 12v DC Logic Power
F9	5A 250v Slo-Blo 12v DC Logic Power
F20	Not Used
F21	5A 250v Slo-Blo 50v DC Coils
F22	8A 250v Slo-Blo 18v DC Controlled Lamps
F23	4A 250v Slo-Blo 5v DC Logic
F24	5A 250v Slo-Blo 6.3v AC G.I. Lamp Insert Left
F25	5A 250v Slo-Blo 6.3v AC G.I. Lamp Lower Half Playfield
F26	5A 250v Slo-Blo 6.3v AC G.I. Lamp Insert Right & Coin Door
F27	5A 250v Slo-Blo 6.3v AC G.I. Lamp Upper Half Playfield
F28	3A 250v Slo-Blo 24v AC Special Relay/Motors (24v Motor)
Cabinet Fuses SERVICE (AC) OUTLET BOX (CABINET BOTTOM)	
Main Fuse Line: 1X 8A 250v Slo-Blo (Int'l) 2X 5A 250v Slo-Blo	
SHAKER MOTOR BD. (FRONT LEFT CAB. SIDE)	
F2	2-1/2A 250v Slo-Blo 9v DC
F3	2-1/2A 250v Slo-Blo 9v DC
OTHER (UNDER PLAYFIELD NEAR BACK)	
n/a	4A 250v Slo-Blo 50v DC Moon Magnet


Display Controller Bd. (holds Display ROM LOC: ROM 0) is positioned behind the 128 X 32 Dot Matrix Display Board. (Both boards have no fuses.)
Fuses in the Cabinet: 1 under the play-field for the magnet in the moon. 2 on the left side of the cabinet (near front) for the Shaker Motor.
Memory Protect & Coil Power Interlock Switches.
8" speaker & transformer in cabinet bottom.
Shaker Motor located in cabinet (near front left)
1X 8 Amp 250v Slo-Blo Fuse & Service Outlet (International uses 2X 5 Amp 250v Slo-Blo Fuses)
Volume Control & Service Switches are located on the Coin Door (Red, Green & Black Buttons).
On/Off Switch under cabinet.

INSTALL (13) BALLS! *APOLLO 13*™ is a (13)-Ball Game!

((8) balls will automatically be fed to the top 8-Ball Lock Trough)

✻ DIAGNOSTIC AIDS ✻

The *display reads* "OPERATOR ALERT..." — A message displayed during Game Mode or Power-Up to alert the operator of a problem.

OPERATOR ALERT works by monitoring any *switch activated coil* that has the potential to trap a ball when disabled (e.g. in the Autolaunch, Scoop, Eject, etc.). If this assembly has a closed switch indicating a ball is stuck or the switch is *stuck closed*, the **CPU Board** will activate the coil ten times. If the switch remains closed, the game will display a message indicating there is a problem (e.g. "**OPERATOR ALERT AUTOLAUNCH NOT WORKING**"). This not only warns the operator of a problem immediately, but indicates exactly where the operator should look to resolve it.

The *display flashes* "OPEN THE COIN DOOR" — This indicates that CMOS RAM memory (CPU Loc. U212) has been corrupted.

This is caused by either failure in memory (e.g. batteries are dead or faulty **RAM**) or upon installation of updated version of code. Opening the Coin Door will initiate a Factory Restore, by opening the Memory Protect Switch. Check battery voltage at **CMOS RAM** with power off.

CPU DIP SWITCH SETTINGS, LOC. SW300 CPU/SOUND BOARD

APOLLO 13: CUSTOM FACTORY ADJUSTMENTS BY COUNTRY*

From the Main Menu in Portals GO TO DIAGNOSTICS MENU

From the Diagnostics Menu GO TO SWITCH MENU

From the Switch Menu GO TO DIP SWITCH TEST

*All countries not noted below use the "USA CPU Country Setting"

CPU COUNTRY SETTING:	Pos.	1	2	3	4	5	6	7	8
USA *	ON								
	OFF	●	●	●	●	●	●	●	●

CPU COUNTRY SETTING:	Pos.	1	2	3	4	5	6	7	8
AUSTRIA	ON	●							
	OFF		●	●	●	●	●	●	●

CPU COUNTRY SETTING:	Pos.	1	2	3	4	5	6	7	8
FRANCE	ON			●	●				
	OFF	●	●			●	●	●	●

CPU COUNTRY SETTING:	Pos.	1	2	3	4	5	6	7	8
JAPAN	ON	●			●				
	OFF		●	●		●	●	●	●

CPU COUNTRY SETTING:	Pos.	1	2	3	4	5	6	7	8
BELGIUM	ON		●						
	OFF	●		●	●	●	●	●	●

CPU COUNTRY SETTING:	Pos.	1	2	3	4	5	6	7	8
GERMANY	ON	●	●	●					
	OFF				●	●	●	●	●

CPU COUNTRY SETTING:	Pos.	1	2	3	4	5	6	7	8
NORWAY	ON		●		●				
	OFF	●		●		●	●	●	●

CPU COUNTRY SETTING:	Pos.	1	2	3	4	5	6	7	8
CANADA	ON	●	●						
	OFF			●	●	●	●	●	●

CPU COUNTRY SETTING:	Pos.	1	2	3	4	5	6	7	8
HOLLAND (DUTCH) & NETHERLANDS	ON			●					
	OFF	●	●		●	●	●	●	●

CPU COUNTRY SETTING:	Pos.	1	2	3	4	5	6	7	8
SWEDEN	ON	●	●		●				
	OFF			●		●	●	●	●

CPU COUNTRY SETTING:	Pos.	1	2	3	4	5	6	7	8
ENGLAND	ON	●		●					
	OFF		●		●	●	●	●	●

CPU COUNTRY SETTING:	Pos.	1	2	3	4	5	6	7	8
ITALY	ON				●				
	OFF	●	●	●		●	●	●	●

CPU COUNTRY SETTING:	Pos.	1	2	3	4	5	6	7	8
SWITZERLAND	ON			●	●				
	OFF	●	●			●	●	●	●

ROM (EPROM/MASKED) SUMMARY TABLE

I.C. NAME	TYPE	BOARD NAME	LOC.	PART Nº
Game ROM	1MB	CPU / Sound Board	U210	965-0208-00
Voice Masked ROM 1	4MB	CPU / Sound Board	U17	965-0209-00
Voice Masked ROM 2	4MB	CPU / Sound Board	U21	965-0210-00
Voice Masked ROM 3	4MB	CPU / Sound Board	U36	965-0211-00
Voice Masked ROM 4	Not Used	CPU / Sound Board	U37	Not Used
Sound EPROM	512K	CPU / Sound Board	U7	965-0212-00
Display EPROM	4MB	Display Controller Bd.	ROM Ø	965-0213-00
Display EPROM	Not Used	Display Controller Bd.	ROM 3	Not Used

From the Main Menu in Portals GO TO DIAGNOSTICS MENU

From the Diagnostics Menu GO TO SWITCH MENU

From the Switch Menu GO TO SWITCH OR ACTIVE SWITCH TEST

From the Switch Menu GO TO DEDICATED SWITCH TEST

SWITCH MATRIX GRID & DEDICATED SWITCHES

Column (Drive) / Row (Return)	1 Q1 GRN-BRN CN5-1	2 Q2 GRN-RED CN5-3	3 Q3 GRN-ORG CN5-4	4 Q4 GRN-YEL CN5-5	5 Q5 GRN-BLK CN5-6	6 Q6 GRN-BLU CN5-7	7 Q7 GRN-VIO CN5-8	8 Q8 GRN-GRY CN5-9
1 WHT-GRY CN7-1	PLUMB BOB TILT 1	ABORT HAN-DLE BALL LAUNCH 9	8-BALL LOCK #1 (TOP) 17	D-O-C-(K) 4-BANK S-U 25	LEFT TURBO BUMPER 33	SPINNER 41	BATTERY 3-BANK S-U (ALL 3) 49	LEFT OUTLANE 57
2 WHT-VIO CN7-2	4TH COIN SLOT 2	5-BALL TROUGH #1 (LEFT) 10	8-BALL LOCK #2 18	D-O-(C)-K 4-BANK S-U 26	BOTTOM TURBO BUMPER 34	NOT USED 42	ROCKET HOME POSITION 50	RIGHT OUTLANE 58
3 WHT-BLU CN7-3	START BUTTON 3	5-BALL TROUGH #2 11	8-BALL LOCK #3 19	D-(O)-C-K 4-BANK S-U 27	RIGHT TURBO BUMPER 35	ROCKET BALL EJECT 43	ROCKET UP POSITION 51	LEFT RETURN LANE 59
4 WHT-GRN CN7-5	RIGHT COIN SLOT 4	5-BALL TROUGH #3 12	8-BALL LOCK #4 20	(D)-O-C-K 4-BANK S-U 28	MOON HOME POSITION 36	RIGHT RAMP EXIT LEFT 44	LEFT TOP LANE 52	RIGHT RETURN LANE 60
5 WHT-YEL CN7-6	CENTER COIN SLOT / DBA 5	5-BALL TROUGH #4 13	8-BALL LOCK #5 21	MOON 4-BANK S-U (LEFT) 29	MOON FORWARD POSITION 37	LEFT ORBIT 45	RIGHT TOP LANE 53	LEFT SLINGSHOT 61
6 WHT-ORG CN7-7	LEFT COIN SLOT 6	5-BALL TROUGH #5 (RIGHT) 14	8-BALL LOCK #6 22	MOON 4-BANK S-U (MID-LT) 30	FOOD SINGLE STAND-UP 38	RIGHT ORBIT 46	CENTER BALL EJECT 54	RIGHT SLINGSHOT 62
7 WHT-RED CN7-8	SLAM TILT 7	5-BALL TROUGH VUK OPTO 15	8-BALL LOCK #7 23	MOON 4-BANK S-U (MID-RT) 31	NOT USED 39	RIGHT BALL EJECT 47	RIGHT RAMP ENTER 55	LT FLIPPER BUTTON VIA Q7 (ON SSFB) 63
8 WHT-BRN CN7-9	NOT USED 8	SHOOTER LANE 16	8-BALL LOCK #8 (BOT-TOM) 24	MOON 4-BANK S-U (RIGHT) 32	WATER SINGLE STAND-UP 40	SUPER VUK (UNDER ARCH) 48	RIGHT RAMP EXIT RIGHT 56	RT FLIPPER BUTTON VIA Q5 (ON SSFB) 64

GND / IC U206 INPUTS	Ground BLK CN6-1
1 GRY-BRN CN6-2	NOT USED DS-1
2 GRY-RED CN6-3	NOT USED DS-2
3 GRY-ORG CN6-4	NOT USED DS-3
4 GRY-YEL CN6-6	NOT USED DS-4
5 GRY-GRN CN6-7	NOT USED DS-5
6 GRY-BLU CN6-8	Normal: Volume In Test: Left RED BUTTON DS-6
7 GRY-VIO CN6-9	Normal: Service Credits In Test: Right GRN BUTTON DS-7
8 GRY-BLK CN6-10	Normal: Begin Test In Test: Enter BLK BUTTON DS-8

From the Diagnostics Menu GO TO LAMP MENU

From the Lamp Menu GO TO SINGLE LAMP TEST

From the Lamp Menu GO TO TEST ALL LAMPS

From the Lamp Menu GO TO ROW OR COLUMN TEST

LAMP MATRIX GRID

Column (18v) / Row (GND)	1: U10 YEL-BRN J13-1	2: U11 YEL-RED J13-3	3: U12 YEL-ORG J13-4	4: U13 YEL-BLK J13-5	5: U14 YEL-GRN J13-6	6: U15 YEL-BLU J13-7	7: U16 YEL-VIO J13-8	8: U17 YEL-GRY J13-9
1: Q33 RED-BRN J12-1	GRID: Life Support #555 Bulb 1	GRID: Manual Burn #555 Bulb 2	GRID: CO_2 #555 Bulb 3	GRID: Master Alarm #555 Bulb 4	GRID: Rocket 2-Ball #555 Bulb 5	GRID: Docking #555 Bulb 6	GRID: Moon's Gravity #555 Bulb 7	GRID: Orbiter #555 Bulb 8
2: Q34 RED-BLK J12-2	SHOOT AGAIN #44 Bulb 9	SPECIAL (Right Outlane) #44 Bulb 10	LITE ORBIT (Rt Return) #44 Bulb 11	LITE ORBIT (Lt Return) #44 Bulb 12	SPECIAL (Left Outlane) #44 Bulb 13	NOT USED 14	GRID: Lite Extra Ball #555 Bulb 15	GRID: Under Volt #555 Bulb 16
3: Q35 RED-ORG J12-3	ORBIT PROGRESS #8 #555 Bulb 17	ORBIT PROGRESS #7 #555 Bulb 18	ORBIT PROGRESS #6 #44 Bulb 19	ORBIT PROGRESS #5 #44 Bulb 20	ORBIT PROGRESS #4 #44 Bulb 21	ORBIT PROGRESS #3 #44 Bulb 22	ORBIT PROGRESS #2 #44 Bulb 23	ORBIT PROGRESS #1 #44 Bulb 24
4: Q36 RED-YEL J12-4	VIDEO #44 Bulb 25	EXTRA BALL #44 Bulb 26	Right Eject Flame #44 Bulb 27	START MISSION (LEM) #44 Bulb 28	ORBIT PROGRESS #12 #44 Bulb 29	ORBIT PROGRESS #11 #44 Bulb 30	ORBIT PROGRESS #10 #44 Bulb 31	ORBIT PROGRESS #9 #44 Bulb 32
5: Q37 RED-GRN J12-5	MOON 4-Bank (Left) #555 Bulb 33	MOON 4-Bank (Mid-Lt) #555 Bulb 34	MOON 4-Bank (Mid-Rt) #555 Bulb 35	MOON 4-Bank (Right) #555 Bulb 36	(D)OCK #44 Bulb 37	D(O)CK #555 Bulb 38	DO(C)K #555 Bulb 39	DOC(K) #555 Bulb 40
6: Q38 RED-BLU J12-6	Left ORBIT #44 Bulb 41	FOOD #555 Bulb 42	Right Orbit Flame #44 Bulb 43	Right Ramp Flame #555 Bulb 44	Rocket Flame #555 Bulb 45	Spinner Flame #555 Bulb 46	Left Orbit Flame #44 Bulb 47	BATTERY #555 Bulb 48
7: Q39 RED-VIO J12-8	Moon Hurry-Up (Ramp) #555 Bulb 49	1-(3) Top Lane Right #44 Bulb 50	(1)-3 Top Lane Left #44 Bulb 51	A13 Spinner Lane #44 Bulb 52	Right ORBIT #555 Bulb 53	Right Turbo Bumper #555 Bulb 54	Bottom Turbo Bumper #555 Bulb 55	Left Turbo Bumper #555 Bulb 56
8: Q40 RED-GRY J12-9	START BUTTON #44 Bulb 57	NOT USED 58	NOT USED 59	WATER #555 Bulb 60	Up-Down Post #44 Bulb 61	MYSTERY #555 Bulb 62	13 BALL BLASTOFF #44 Bulb 63	BLASTOFF LETTER (Ramp) #555 Bulb 64
9: Q41 RED-WHT J12-10	(B)LASTOFF #44 Bulb 65	B(L)ASTOFF #44 Bulb 66	BL(A)STOFF #44 Bulb 67	BLA(S)TOFF #44 Bulb 68	BLAS(T)OFF #44 Bulb 69	BLAST(O)FF #44 Bulb 70	BLASTO(F)F #44 Bulb 71	BLASTOF(F) #44 Bulb 72
10: Q42 RED J12-11	NOT USED 73	NOT USED 74	NOT USED 75	NOT USED 76	NOT USED 77	NOT USED 78	NOT USED 79	NOT USED 80

From the Main Menu in Portals GO TO DIAGNOSTICS MENU

From the Diagnostics Menu GO TO COIL MENU

From the Coil Menu GO TO COIL TEST

From the Coil Menu GO TO CYCLING COILS

COILS DETAILED CHART TABLE

High Current Coils Group 1		Drive Transistor (D.T.)	Driver Ouput Board	D.T. Control Line Color	D.T. Control Line Connect	Power Line Color	Power Line Connnection	Power Voltage	Coil GA/Turn
#1	TROUGH UP-KICKER	Q1	I/O Pwr. Drvr.	BRN-BLK	J8-P1	YEL-VIO	J10-4/5	50v	25-1240 090-5036-01
#2	AUTO LAUNCH	Q2	I/O Pwr. Drvr.	BRN-RED	J8-P3	YEL-VIO	J10-4/5	50v	24-940 090-5036-01
#3	RIGHT BALL EJECT	Q3	I/O Pwr. Drvr.	BRN-ORG	J8-P4	YEL-VIO	J10-4/5	50v	27-1500 090-5004-01
#4	CENTER BALL EJECT	Q4	I/O Pwr. Drvr.	BRN-YEL	J8-P5	YEL-VIO	J10-4/5	50v	27-1500 090-5004-01
#5	ROCKET BALL EJECT	Q5	I/O Pwr. Drvr.	BRN-GRN	J8-P6	YEL-VIO	J10-4/5	50v	28-1050 090-5046-00
#6	NOT USED	Q6	I/O Pwr. Drvr.	BRN-BLU	J8-P7	BRN	— - —	---	— - —
#7	SHAKER MOTOR	Q7	I/O Pwr. Drvr.	BRN-VIO	J8-P8	YEL-VIO	J10-4/5	50v	N/A
#8	KNOCKER	Q8	I/O Pwr. Drvr.	BRN-GRY	J8-P9	YEL-VIO	J10-4/5	50v	23-800 090-5001-01

High Current Coils Group 2		Drive Transistor (D.T.)	Driver Ouput Board	D.T. Control Line Color	D.T. Control Line Connect	Power Line Color	Power Line Connnection	Power Voltage	Coil GA/Turn
#9	LEFT TURBO BUMPER	Q9	I/O Pwr. Drvr.	BLU-BRN	J9-P1	YEL-VIO	J10-4/5	50v	26-1200 090-5044-00
#10	BOTTOM TURBO BUMPER	Q10	I/O Pwr. Drvr.	BLU-RED	J9-P2	YEL-VIO	J10-4/5	50v	26-1200 090-5044-00
#11	RIGHT TURBO BUMPER	Q11	I/O Pwr. Drvr.	BLU-ORG	J9-P4	YEL-VIO	J10-4/5	50v	26-1200 090-5044-00
#12	LEFT SLINGSHOT	Q12	I/O Pwr. Drvr.	BLU-YEL	J9-P5	YEL-VIO	J10-4/5	50v	26-1200 090-5044-00
#13	RIGHT SLINGSHOT	Q13	I/O Pwr. Drvr.	BLU-GRN	J9-P6	YEL-VIO	J10-4/5	50v	26-1200 090-5044-00
#14	SUPER VUK (UNDER ARCH)	Q14	I/O Pwr. Drvr.	BLU-BLK	J9-P7	YEL-VIO	J10-4/5	50v	24-940 090-5036-01
#15	LEFT FLIPPER ENABLE	Q15	I/O Pwr. Drvr.	ORG-GRY	J9-P8	GRY-YEL	J10-4/5	50v	22-1080 090-5032-00
#16	RIGHT FLIPPER ENABLE	Q16	I/O Pwr. Drvr.	ORG-VIO	J9-P9	BLU-YEL	J10-4/5	50v	22-1080 090-5032-00

Low Current Coils Group 1		Drive Transistor (D.T.)	Driver Ouput Board	D.T. Control Line Color	D.T. Control Line Connect	Power Line Color	Power Line Connnection	Power Voltage	Coil GA/Turn
#17	5-BALL TROUGH LOCK BALL	Q17	I/O Pwr. Drvr.	VIO-BRN	J7-P2	BRN	J7-1	20v	25-1240 090-5036-01
#18	UP/DOWN RAMP	Q18	I/O Pwr. Drvr.	VIO-RED	J7-P3	BRN	J7-1	20v	27-1500 090-5004-01
#19	MOON MOTOR RELAY	Q19	I/O Pwr. Drvr.	VIO-ORG	J7-P4	BRN	J7-1	20v	24V DC 10A DPDT
#20	ROCKET MOTOR RELAY	Q20	I/O Pwr. Drvr.	VIO-YEL	J7-P6	BRN	J7-1	20v	24V DC 10A DPDT
#21	TRAP DOOR	Q21	I/O Pwr. Drvr.	VIO-GRN	J7-P7	BRN	J7-1	20v	28-1050 090-5046-00
#22	8 BALL LOCK PLUNGER	Q22	I/O Pwr. Drvr.	VIO-BLU	J7-P8	BRN	J7-1	20v	27-1500 090-5004-01
#23	UP/DOWN POST	Q23	I/O Pwr. Drvr.	VIO-BLK	J7-P9	BRN	J7-1	20v	27-1500 090-5004-01
#24	NOT USED	Q24	I/O Pwr. Drvr.	VIO-GRY	J7-P10	BRN	— - —	---	— - —

FLIPPER COILS

SSFB №	Flipper Coil	Cabinet Switch	Switch Drive	Switch Return	E.O.S.	GND	Flipper 50v DC Power	Flipper 8vAC Hold	Flipper Coil Output
SSFB 1	Lwr. Rt. Flipper 22-1080	BLU-VIO SSFB CN1-7	GRN-GRY CPU CN8-9 TO SSFB CN1-4	WHT-GRY CPU CN10-1 TO SSFB CN1-3	BRN-VIO RT. EOS SW. TO CN1-1	BLK CPU CN5 TO CN1-6	BLK-WHT PPB J7-1, -5 to SSFB CN2-11, 12	GRY-GRN-GRY P/S CN1-10, -11, to SSFB CN2-9, 10	50v Q2, Q3, 8vAC SR1 CN2-7, 8
SSFB 1	Lwr. Lt. Flipper 22-1080	BLU-GRY SSFB CN1-10	GRN-GRY CPU CN8-9 TO SSFB CN1-4	WHT-VIO CPU CN10-2 TO SSFB CN1-5	BRN-GRY LT. EOS SW. TO CN1-9	BLK CPU CN5 TO CN1-6	BLK-WHT PPB J7-1, -5 to SSFB CN2-11, 12	GRY-GRN-GRY P/S CN1-10, -11, to SSFB CN2-9, 10	50v Q2, Q10, 8vAC S R2 CN2-4, 5

From the Main Menu in Portals GO TO DIAGNOSTICS MENU

From the Diagnostics Menu GO TO COIL MENU

From the Coil Menu GO TO COIL TEST

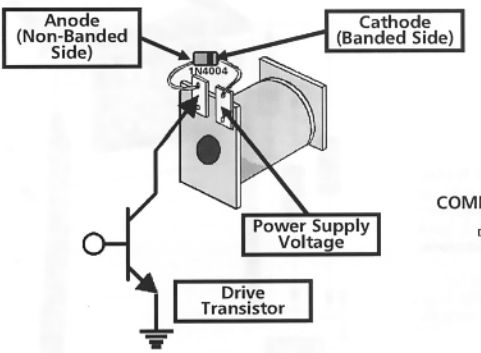
From the Coil Menu GO TO CYCLING COILS

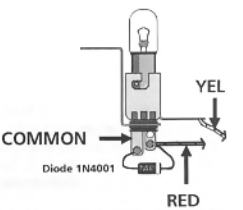
Coils Detailed Chart Table Continued

Flash Lamps (FLAMP)			Drive Transistor (D.T.)	Driver Ouput Board	D.T. Control Line Color	D.T. Control Line Connect	Power Line Color	Power Line Connnection	Power Voltage	Bulb Type
#1	Under Right Ramp	X3	Q25	I/O Pwr. Drvr.	BLK-BRN	J6-P1	ORG	J6-P10	20v	3X #906 165-5004-00 1X #89 165-5000-89
	Backbox Insert	X1								
#2	Under Right Ramp	X3	Q26	I/O Pwr. Drvr.	BLK-RED	J6-P2	ORG	J6-P10	20v	3X #906 165-5004-00 1X #89 165-5000-89
	Backbox Insert	X1								
#3	Under Right Ramp	X3	Q27	I/O Pwr. Drvr.	BLK-ORG	J6-P3	ORG	J6-P10	20v	3X #906 165-5004-00 1X #89 165-5000-89
	Backbox Insert	X1								
#4	Pop Bumper Area	X2	Q28	I/O Pwr. Drvr.	BLK-YEL	J6-P4	ORG	J6-P10	20v	4X #89 165-5000-89
	Backpanel	X1								
	Backbox Insert	X1								
#5	Upper Right Playfield	X1	Q29	I/O Pwr. Drvr.	BLK-GRN	J6-P5	ORG	J6-P10	20v	4X #89 165-5000-89
	Lower Right Playfield	X2								
	Backpanel	X1								
#6	Upper Left Playfield	X1	Q30	I/O Pwr. Drvr.	BLK-BLU	J6-P6	ORG	J6-P10	20v	3X #89 165-5000-89
	Lower Left Playfield	X1								
	Backpanel	X1								
#7	Pop Bumper Area	X1	Q31	I/O Pwr. Drvr.	BLK-VIO	J6-P7	ORG	J6-P10	20v	3X #89 165-5000-89
	Backpanel	X1								
	Backbox Insert	X1								
#8	Rocket Area	X2	Q32	I/O Pwr. Drvr.	BLK-GRY	J6-P8	ORG	J6-P10	20v	4X #89 165-5000-89
	Backbox Insert	X2								

Aux. Data Line			Driver Ouput Board LOC: Under Playfield	D.T. Control Line Color	D.T. Control Line Connect	Power Line Color	Power Line Connnection	Power Voltage	
#1	Magnet Grab		Magnet Driver	BLUE	P4	YEL-VIO	P3	50v	
#2	Magnet Hold		Magnet Driver	BLUE	P4	YEL-VIO	P3	50v	

TYPICAL SWITCH, COIL & LAMP WIRING





POWER REQUIREMENTS

This game ***must be connected to a properly grounded outlet to reduce shock hazard*** and insure proper game operation. See Section 5, Chapter 1, Cabinet Schematics & Troubleshooting (AC Power Wiring Diagram), for transformer connections required for **Normal**, **High**, and **Low Line** conditions.

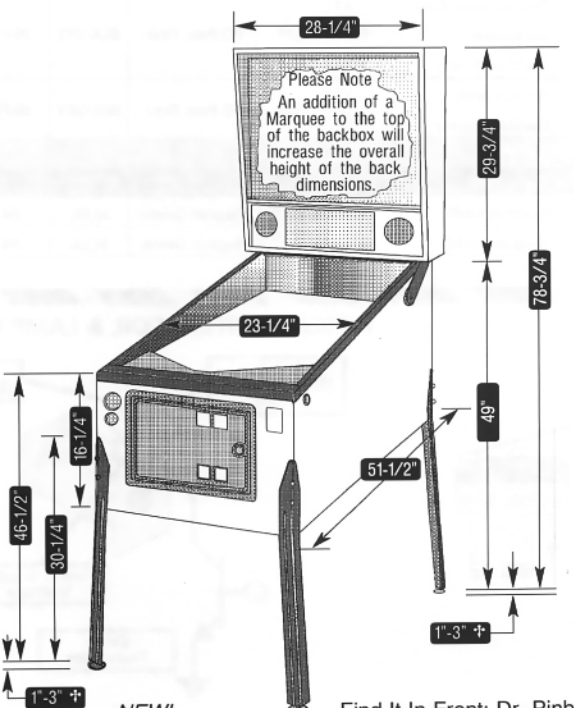
Normal Line:	110v AC - 125v AC @ 60Hz	
Domestic uses an 8AMP 250v Slo-Blo Fuse.	AVG OPERATION	MAX OPERATION
	CURRENT: 2.8AMP WATTAGE: 329w	CURRENT: 8AMP WATTAGE: 940w
High Line:	218v AC - 240v AC @ 50Hz	
Export uses 2 X 5AMP 250v Slo-Blo Fuses. (*England & Hong Kong use an 8AMP 250v S/B Fuse.)	AVG OPERATION	MAX OPERATION
	CURRENT: 1.8AMP WATTAGE: 412w	CURRENT: 5AMP | 8AMP* (England & Hong Kong use an 8A F.) WATTAGE: 1145w | 1832w*
Low Line:	95v AC - 108v AC @ 50Hz / 60Hz	
Export Japan Only uses an 8AMP 250v Slo-Blo Fuse.	AVG OPERATION	MAX OPERATION
	CURRENT: 2.6AMP WATTAGE: 264w	CURRENT: 8AMP WATTAGE: 812w

TRANSPORTATION

To reduce the possibility of damage, observe the following precautions whenever transporting the game. Lower the backbox and secure it to the cabinet. Remove the legs and secure the game within the transporting vehicle. Reference Section 1, Chapter 1, Game Set-Up for assembly (for disassembly reverse instruction order).

OVERALL DIMENSIONS †

Shipping Crate Dimensions	
Height:	55½"
Width:	30½"
Length:	31"
Weight:	250lbs. (+/- 10lbs.)



† **Note:** The Leg Levelers can add up to two (2) inches to the overall height of the front & back dimensions.

The cabinet is designed to give a 6.5° pitch with the Leg Levelers turned all the way in.

NEW!

Find-It-In-Front: Dr. Pinball

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Game Set-Up

Game Assembly Procedures

(Refer to the Illustrations on the inside front cover and pages ii & 2)

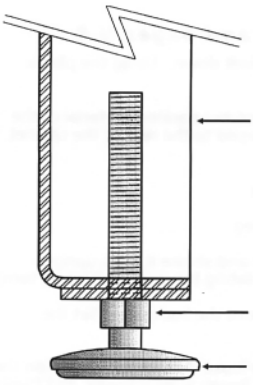
1. Open the top of the carton and lay it on its side with the bottom of the cabinet down. Using the plastic banding strip as a handle, slide the game out of the carton.
2. Remove all packing material. 4 cabinet legs & levelers (attached) are in the corner packing material of the crate. A large Allen Wrench (use for securing the backbox) is inserted and taped to the rear of the cabinet. Miscellaneous parts are in the cash box.
3. Support rear of cabinet and attach rear legs using two leg bolts for each leg.
4. Support front of cabinet and attach front legs using two leg bolts for each leg.
5. While assuring that no cables are being pinched, carefully raise the backbox and secure it in its upright position with the Allen Wrench in the hole in the back of the cabinet and rotating the wrench 270° (¾ turn).
6. Remove the backbox keys from the playfield glass, unlock and carefully remove the backglass. Set the backglass aside.
7. Check all connectors in the backbox for loose wire terminations. Reseat any loose wire by pushing in on the terminal. Push on all connectors plugged into the CPU Board, Sound Board, Power Supply Board, and Display Board to check that they are properly seated.
8. Check that all fuses are seated properly.
9. Carefully remove the playfield glass and set it aside.
10. Remove all shipping tie downs, shipping instruction pages, packing foam, etc. (if any) Read all printed information taken from the playfield. It contains warning(s), caution(s) and/or information specific to the game.
11. Raise the playfield and support it, by lifting the Stay Arm on the Right Side of the Cabinet and locking it into the slotted bracket (or hole) on the under playfield. See the illustration "Easy Access Service System" opposite this page.
12. Check all cabinet cables and playfield Lamp Boards connector terminations.
13. Remove the Plumb Bob tilt from the parts package and install on the pendulum wire on the inside left of the cabinet. See Section 4, Chapter 1, Parts Identification & Location.
14. Lower the playfield and ensure game is level side-to-side by adjusting Leg Levelers, if required. See the illustration "Leg Leveler Adjustment" opposite this page.
15. With the Leg Levelers turned all the way in, the game pitch is 6.5°; depending on the condition of the floor, adjust the Leg Levelers as required.

The playfield incline affects difficulty of play. Use the recommended incline; Game difficulty is best varied using game adjustments.

16. Check the plumb tilt and adjust as required.
17. If desired, perform any self tests at this time. See Section 3, Chapter 1, Portals™ Service Menu Introduction, and Chapter 2, Diagnostics, for instructions on how to enter "Begin Play Test" and "'Game' Specific" to test components on the game.
18. With the Backbox Insert Door closed, carefully reinstall and lock the backglass.
19. **INSTALL 13 BALLS** on the playfield near the outhole and carefully reinstall the playfield glass. (Amount of balls are always specified on decal attached to the lock down assembly.)
20. If desired, make Game Pricing (Standard and/or Custom) and Add-A-Ball, Novelty, or X-Ball Play adjustments at this time. See Section 3, Chapter 4, Adjustments, for instructions on how to enter adjustments. Follow instructions in the tables provided in the manual for suggestions of customizing changes.

Leg Leveler Adjustment

This cabinet is designed to automatically have a 6.5° pitch without any Leg Leveler adjustment!



STEP 1

Assemble all (4) legs and levelers as shown in the diagram. Be sure the leveler is turned all the way in.

STEP 2

Attach leg assemblies to cabinet with leg bolts provided.

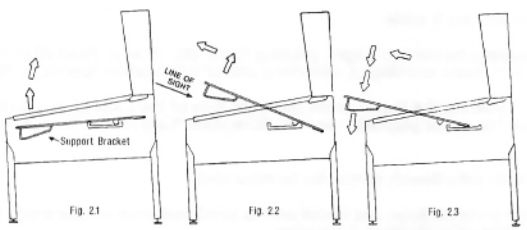
YOUR PLAYFIELD PITCH IS NOW AT 6.5° AS REQUIRED FOR PROPER GAME PLAY!

STEP 3

Verify 6.5° pitch. Minor adjustment(s) may be necessary depending on the location floor being level.

For custom adjustment greater than 6.5° can be acheived by turning out the rear leg leveler(s), however, it is not recommended.

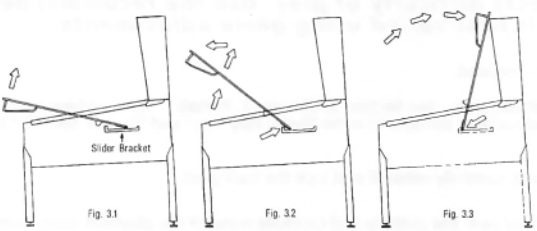
Easy Access Service System



Service Position 1
This position is useful to service:

Trough Switches, Connectors at back of cabinet, Cleaning the Playfield, etc.

Lift the playfield ***using the left and right ball guides*** upward (Fig. 2.1) until the playfield support brackets can be seen to clear cabinet front (Fig. 2.2). At this time, pull playfield toward the front of the cabinet, checking that the mechanical components clears the cabinet front (Fig. 2.3). Then rest the playfield on the support brackets at the front channel of cabinet. ***Reverse procedure when service is complete.***



Service Position 2
This position is useful to service:

All Playfield Bottom Components, Cabinet Components, etc.

With the playfield at rest (Fig. 3.1), hold sides of playfield and pull toward the front of the cabinet (approx. 6" to 8"), until resistance is felt from the slider brackets located on either side of the cabinet (Fig. 3.2). At this time, swivel playfield toward the backbox, then rest on top edge of the backbox. ***Reverse procedure when service is complete.***

Game Operation & Features

Start of Game Features

Starting a Normal Game

Insert coin(s), the game generates a sound for the first coin & for each subsequent coin(s) with the display indicating the number of credit(s) posted. Press the **START BUTTON** and a start-up sound is produced, and the posted credit(s) are reduced by one. The display awaits choice from player 1 to select **REGULAR GAME** rules or **NOVICE GAME** rules with the *flipper buttons*. If the player *does not select rules*, the game will default to ***Regular Rules***. After selection (or time-out default to Regular Game) subsequent players can be added (**up to 6 can play!**) by pressing the **START BUTTON** before the end of ball 1. **Note 1:** The subsequent players will play the same game (Novice or Regular) determined by Player's 1 choice. **Note 2:** This feature can be adjusted with Adj. ##, Name of Adjustment. Default is **On**. Set to **Off** to turn off this feature.

The display now indicates the player or # of players selected from the total depressions of the **START BUTTON**. The display indicates the ball in play, and a ball is served to the *Shooter Lane*. An introduction is shown followed by Skill Shot Graphics. Pressing the **START BUTTON** after ball 1 of any player will start a new game (if credits are available), ***but only*** if the **START BUTTON** is depressed for 2-3 seconds. This delay is to avoid accidental "re-starts" of a game. (Note: Any ½ credit remaining during game play after the end of ball 1, or power down, will be eliminated.)

Starting Team Play (Doubles!)

Team Play is a four player game. The totals for players 1 & 3 (Team 1) and players 2 & 4 (Team 2) are displayed individually as well as the combined score for both teams. Team Play does not work with less than or more than 4 players. 1-, 2-, 3-, 5- & 6-Player games, the individual scores are shown.

Starting League/Tournmanent Play

After credit is posted, while holding in the **LEFT FLIPPER BUTTON**, press the **START BUTTON**. League Play has now begun. The differences between Normal Game Play and League/Tournament Play are: There is no "auto-percentaging" (awarding extra balls, specials, etc. to players with very low scores on the second or third ball). Mystery Features are awarded in a set order rather than random in Normal Game Play. Percentage Game Features are not automatically advanced as they are for the Regular Play Features.

Starting Pinball Wizard Play

After credit is posted, while holding in the **RIGHT FLIPPER BUTTON**, press the **START BUTTON**. Pinball Wizard Play has now begun. The same as League/Tournament Play, but ooooooooh! so much gosh darn harder!

Extra Ball (EB) Buyin (This game only)

An option to add an extra ball(s) after the game is finished is given (it doesn't matter if the game is set as a 2-, 3-, 4-, or 5-Ball Game). The score and game features already earned are retained and the player can add to the score with this extra ball. To activate the ***EXTRA BALL BUY-IN FEATURE***, adjustment 34, Buyin Type, must be to set **ON** (Default=**Off**). When set to **ON**, at the end of normal game play, the same player may choose to continue the game at the same score and features active by adding 1 coin for 1 extra ball (existing credits will not work) prior to the expiration of the "countdown timer." Letting the timer to expire, pressing the **START BUTTON** or ***BOTH*** flippers simultaneously cancels this feature.

During Game Features

Video Mode

Our games feature elaborate video modes and video graphics. Don't forget to watch the display for hints or feature demonstrations. The video modes require the player to play on-screen. When in video mode, the ball-in-play is "held" (usually in a Scoop, Eject Saucer or lock of some sort). The interactive video play requires the player to use the flipper buttons to play the mode.

Feature Mode & Combination Shots

Features are lit on the playfield and started by completing certain play shots (e.g. completion of target banks, orbit(s), ramp(s) and/or any combination of the shots). Combination shots (combos) are a series of shots completed in many different variations. For example, a shot to the Ramp with the ball being returned to the Left Inlane then immediately shot to the Orbit of the playfield returning to a Flipper and then shot to another Ramp is a hard combo shot worthy of many points. These combinations vary per game. For feature modes & combos certain points or awards are given after completion. Watch the Video Display for feature details, etc.

Multiball

Multiball is started after completion of certain Feature Modes or may be a mode itself depending on game rules and play. Multiball may vary with the amount of balls used in Multiball depending on game style. Typically, if Multiball play was short, a "restart" option is given. Watch the Video Display for instructions on the restart.

Replay Feature

Replay awards are given as the player exceeds a High Score Level during game play. This can be adjusted with Adjustment 3, Replay Awards (Default=**CREDIT**, adjustable). Players exceeding the High Score Levels can receive a **CREDIT**, an **EXTRA BALL**, or **SPECIAL**. Adjust to **NONE** if a replay award is not desired.

End of Game Features

Game Endings

When all player(s) have played all balls (including any Extra Ball Buyin's), the game ends. If power is interupted during the course of a game, it will end that game (***see Starting a Normal Game***). Depending on the number of tilts set (Default=2, adjustable), or prolonged closure of the Plumb Bob Tilt Switch, tilts the ball in play. Closure of the Slam Tilt Switch on the coin door ends the current game(s).

Match Feature

At the end of each ball, earned bonuses are collected. At the end of the last ball of a game (including any extra balls, if applicable), earned bonuses are collected, then the system produces a random 2-digit number (a multiple of 10; 00 to 90). Matching the last two digits of the player's score with this number awards a credit. In Adj. 11, Match Percentage (Default=**7%**, adjustable) can be changed from 0-10%. Changing the percentage to **0%** displays the "Match Animation" at the end of the game, however, will never match (to award a credit). Changing this adjustment to **OFF** will not display the "Match Animation" nor award a credit.

Entering Initials

If player achieved a new high score in any of the 3 categories (Regular, Novice or Wizard), the player may enter his/her initials. To enter your initials, use the left & right flipper buttons to choose letter or character as seen on the Visual Display. Hitting the Start Button locks the letter or character in. Procede with the 2nd & 3rd letter. The game then proceeds into the game-over mode and then to the attract mode. A custom message (adjustable) can be displayed during the attract mode.

Manual Percentaging

This game is equipped with Manual Percentage Adjustment. As previously with our games, you can either set operator adjustments for a replay percent or you can set a fixed replay score. See Section 3, Chapter 4, Adjustments, Adjustment 1 & 2.

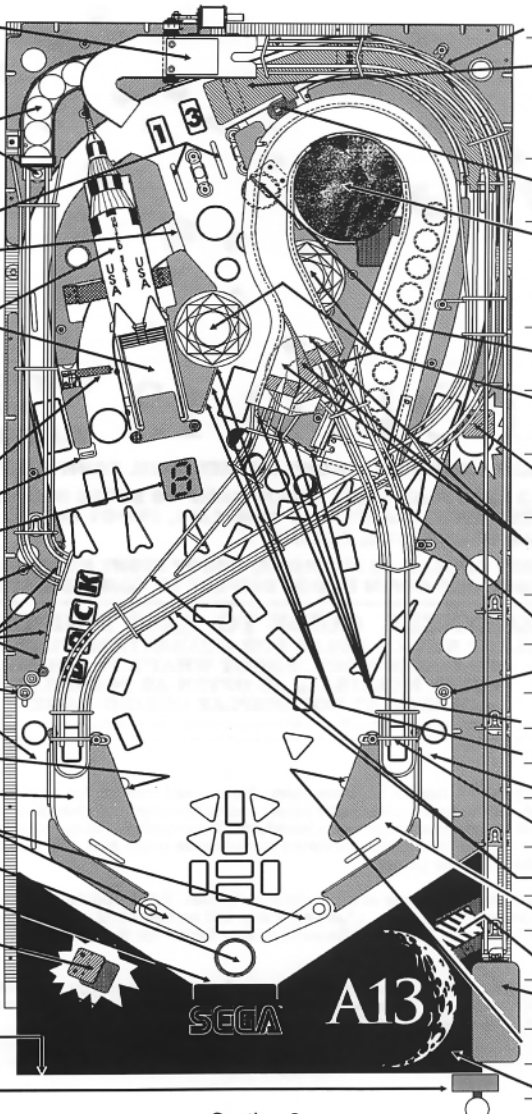
If you set operator adjustments for a particular replay percent, the game will compute a recommended score to keep the game at that replay percentage. If a change is recommended and the game coin door is opened, the display will indicate if the replay is too high or low and make a sound to alert the operator. By pressing the start button, the score to beat will be changed to a more correct level. If you close the coin door or enter the **Portals™ Service Menu**, no score change will be made.

You may choose to ignore the recommended change; for example, you may not think last week's players were the usual crowd. Just close the door and the message will disappear without altering the existing level. Or you may choose to make a different score to beat adjustment; this is done by utilizing Adj. 2, Replay Levels.

Game Rules

Overview

Below is the Apollo 13™ Playfield with all of its component locations indicated (for details on these parts, see Section 4). Read over the components below to help in understanding the effects of the game rules. The rules are numbered and divided into four groups: **Single Ball Play, Multiball & Jackpots, A13 Missions,** and ***Mission Control Game Rule Notes***.



Upper Trough / Trap Door Assembly
From the Ball Launch, balls are fed through the trap door to fill the 8-Ball Lock Trough or pass over the closed trap door to enter the top lanes.

8-Ball Lock Trough & Lock Plunger Assemblies
The plunger retracts allowing the eight balls to roll into the ramp and exit over the "K" in "DOCK" targets.

Top Lanes "1" & "3"

1-Way Gate
Prevents the ball from rolling back down into this spinner lane.

Rocket Ramp Assembly
Balls are shot up into the rocket and held by a mini-vuk. Depending on game play, the ball is either returned to play or the rocket will move up and release the ball into the undertrough. This ball will roll down to the bottom arch and will be served back into play via the autolaunch.

Spinner Assy. "Mystery"

Stand-Up Target "Food"

LED Readout Display "Multiball Countdown"

8-Ball Trough Exit Wire Ramp

Stand-Up Targets "D-O-C-K"

Adjustable Post Left Outlane Widen/shorten outlane.

Left Outlane (Drain)

Left Slingshot Assembly

Left Return Lane

Left & Right Flippers Assy.

Up/Down Post Assembly

Outhole (Center Drain)

Super VUK (Under Arch)
When a ball is fed into the trough via the Rocket (Up Position) or the Moon Magnet, the ball rolls down to this VUK and is kicked out and fed into the 5-Ball Trough.

Start (Credit) Button

Abort Handle (A13 Shooter) Assembly

Shooter Lane Wire Ramp

Up/Down Metal Ramp Assembly When the ramp is down, a ball shot via the left orbit will roll up onto this ramp and exit onto the dual wire ramp dropping the ball over the left return lane. otherwise left or right orbit shot can be made.

Up/Down Ramp Plunger Assembly Used to move the ramp into the up or down position.

Moon Assembly
When a ball is shot up the plastic ramp (magnet is activated) the magnet will grab the ball, rotate forward and the ball drops into the exit hole into the trough.

Center Eject Assembly
This eject is located (hidden) under the plastic ramp by the top lanes.

Pop Bumpers
The bottom pop bumper is hidden under the plastic ramp exit area.

Right Eject Assembly
This eject is located (hidden) under the LEM and butyrate.

Plastic Ramp & Exit Ramp Ball Diverter Assemblies
When the ball exits, the diverter will move closing the left or right exit.

Stand-Up Target "Water" By ramp entrance.

Adjustable Post Right Outlane Widen/shorten outlane.

Stand-up Targets "Moon"

Stand-Up Targets "Battery"

Right Outlane (Drain)

Exit to Right Return Lane Wire Ramp

Dual Exit to Left Return Lane Wire Ramp

Right Return Lane

5-Ball Trough & Exit Scoop Assemblies

Auto Ball Launch Assembly Under Butyrate.

Right Slingshot Assembly

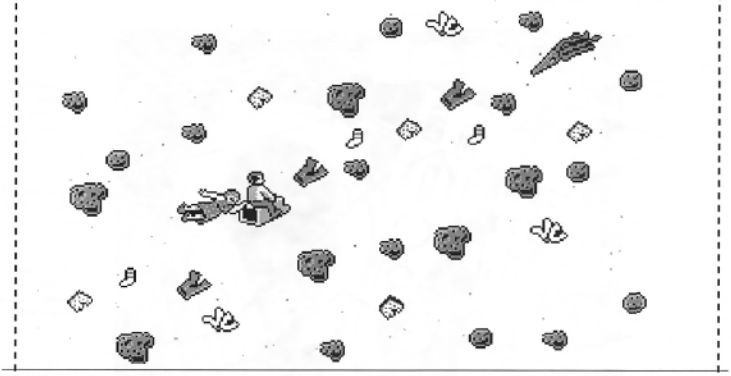
Bottom Arch Assembly

Game Rules

Instruction Card

Below is a copy of the game instruction card which is included with every game. If this card is lost or damaged, simply copy this page and cut out the instruction card as a temporary replacement until a new card is ordered. (Suggestion: Copy & cut along the dotted line and fold in the center. This will keep the "copy" sturdy.)

Copy & Cut



Fold Fold

APOLLO 13™

FEATURING 13 BALL MULTIBALL!

TO START MULTIBALL, SHOOT ROCKET UNTIL COUNTDOWN IS 0.

FOR 13 BALL PLAY, FIRST SHOOT RAMP TO SCORE BLASTOFF LETTERS. WHEN BLASTOFF IS COMPLETE, SHOOT ROCKET UNTIL 13 BALL COUNTDOWN REACHES 0.

TO START APOLLO 13 MISSIONS, SHOOT RIGHT HOLE. FOLLOW INSTRUCTIONS GIVEN IN DOT DISPLAY TO COMPLETE MISSION.

BEGINNERS' GUIDE TO SEGA PINBALLS:

- **SELECT NOVICE RULES FOR GUARANTEED PLAY TIME.**
- **TO SCORE MORE, SHOOT WHAT'S FLASHING!**
- **PLAY MULTIBALL AS OFTEN AS POSSIBLE!**
- **GLANCE AT DOT DISPLAY DURING GAME!**

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The remainder of this chapter is Apollo 13 Game Rules. Please read through for a better understanding of the operation of this game. Some game rules, point values and/or features may change as production continues. The changes, if any, will be describe in manual addendums, if warranted. Please note, that some adjustments (see Section 3, Chapter 4, Adjustments) are designed to customize game play, (i.e. making it harder or easier as players get more familiar with the game).

Code revisions and updates may change as production continues. Code updates will be made available to distributors via ROM, diskette or modem. Changes, if any, will be described with the code updates. See the end of this manual for "Appendix A - Pinball Game Firmware Table," for the latest revision code for all games prior to this game.

See the end of this manual for "Glossary of Terms," for words or acronymns you may not understand. If an acronym or expression is not in this glossary, please call our Technical Support Department, so we may add it in the next game manual. Any other suggestions or comments are always welcome!

1 GAME RULES SELECT:

Select **REGULAR GAME** rules or **NOVICE GAME** rules with the *flipper buttons*. If the player *does not select rules*, the game will default to ***Regular Rules***. (Note: Subsequent players will play the game style chosen by player 1.)

NOVICE GAME rules give the player a guaranteed minimum game time - ***if the ball drains before this time is up, it will be returned to the player.*** When the ball drains after time is up, the game ends.

2 SKILL SHOT SELECT:

Select one of the three items shown in the display:

- **START MISSION** - Starts Apollo 13 Mission.
- **MYSTERY** - Gives *Mystery Award*.
- **MULTIBALL COUNTDOWN** - With **B L A S T O F F** ***incomplete*** puts player 1 shot closer to starting ***Multiball***.

or

- **13 MILLION** - With **B L A S T O F F** or ***MULTIBALL READY complete*** gives player 13M points.

3 TOP LANES:

Complete the ***Top Lanes*** **"1"** & **"3"** to advance **Spinner** and **Turbo Bumper** values up to a maximum of 2M.

4 MOON TARGETS & MOON HURRY UP

Complete the ***Moon Targets*** from ***left*** to ***right*** to light the **Ramp** for ***Moon Hurry Up***. The **Turbo Bumpers** and **Spinner** advance the ***Moon Hurry Up*** value.

5 DOCK TARGETS & MYSTERY

Complete the ***D-O-C-K Targets*** to light ***Mystery***, collected at the **Center Eject**. A ***Mystery Award*** may also be collected at Skill Shot Select. ***Mystery Awards*** include:

- **13 BALL PLAY**
- **EXTRA BALL**
- **MYSTERY 3-BALL**
- **BIG POINT VALUES**
- **HOLD BONUS**
- **LIGHT SPECIAL**
- **DOUBLE BONUS**
- **HIDDEN VIDEO MODE**

6 BATTERY TARGETS

Shoot the ***Battery Targets*** to recharge the battery. Fully charging the battery scores **POINTS**, or **LIGHTS EXTRA BALL** or **SPECIAL**.

7 FOOD & WATER TARGETS

The ***Food & Water Targets*** score increasing millions when hit.

SINGLE BALL PLAY

8 ORBIT FEATURES

Shooting lit **Orbits** advances the ***Spacecraft Lamps*** in the center of the playfield. Then...

- Scoring two **Orbits** will light the ***LANDER VIDEO MODE*** at the **Right Eject**.
- Scoring five **Orbits** starts ***POWER DOWN*** - shoot all **Flashing Shots** before ***"AMPS=0"***.
- Scoring eight **Orbits** starts ***POWER UP*** - shoot **Flashing Shots** in order.
- Scoring twelve **Orbits** starts ***SPLASHDOWN***, a timed ***Multiball Feature*** where the **Orbits** score **Jackpots**.

9 VIDEO MODE

Shoot **Right Eject** when lit to play video mode. Land ***Spacecraft*** on the moon before fuel runs out. Use the **Left Flipper** to fire the *left thruster* (move right), the **Right Flipper** to fire the *right thruster* (move left), and **Both Flippers** to fire the *bottom thruster* (move up). Use the **Ball Launch** to 'zero' sideways velocity & thrust up hard.

10 EXTRA BALL

Shoot **Right Eject** when lit to collect an ***Extra Ball***. If the maximum number of ***Extra Balls*** have already been awarded, the player will score points instead. The ***Extra Ball*** can be lit from • **MISSION START** • **MYSTERY** • **THE BATTERY** or • **VIA PERCENTAGING.**

11 SPECIAL

Lit **Outlanes** score a ***Special***. A ***Special*** is lit from • **MYSTERY** or • **VIA PERCENTAGING.**

12 STARTING MULTIBALL:

Shoot the **Rocket** until the **Countdown** on the *LED* reaches zero [*0*]. The **Rocket** will elevate, kick the ball out, and the remaining balls will be issued from the **8-Ball Lock Trough**.

12a REGULAR MULTIBALL JACKPOTS:

If ***Multiball*** is started and **B L A S T O F F** is not complete, the player will recieve 2-4 balls in play. Four (4) **Jackpots** will be lit, at the **Left Orbit**, **Spinner**, **Right Orbit**, and the **Right Eject**. The Starting Jackpot value is a base value multiplied by the number of balls in play. The **Jackpot** value can be increased by shooting the **Rocket** during ***Multiball***—the **Jackpot** will increase by 1M times the value shown on the *LED* when the **Rocket** is hit. Switch closures may also increase the **Jackpot**.

12b REGULAR MULTIBALL SUPER JACKPOTS:

The timed **Super Jackpot** is lit when all four ***Moon Targets*** are completed or all **4 (four) Jackpots** are scored. During ***Multiball*** the ***Moon Targets*** must be completed from **left** to **right** - when no *targets* are lit, the left most target is available. When that target is hit, the 2nd target is available, etc.

13 STARTING 13 BALL MULTI-BALL & BLASTOFF LETTERS

During ***Single Ball Play***, two combination shots award letters in **B L A S T O F F**. These shots are:

- ***Ramp ⇨ Left Flipper ⇨ Ramp*** and
- ***Ramp ⇨ Right Flipper ⇨ Orbit Up/Down Ramp ⇦ Left Flipper ⇨ Ramp***

When **B L A S T O F F** is completed, the ***NEXT*** player to start ***Multiball*** will be awarded ***13 Ball Multiball***.

Easier difficulty settings allow the player to score a **B L A S T O F F** letter the first time the **Ramp** is shot for each ball played or in each game played.

B L A S T O F F letters carry over from player to player, game to game.

13a 13 BALL MULTIBALL ROCKET JACKPOTS:

During ***13 Ball Multiball***, shoot the **Rocket** for **Jackpots**. The starting **Jackpot** value is equal to a base value multiplied by the number of balls in play. Every 10 switch closures increase the **Jackpot** value by 1M. Scoring **5 (five) Jackpots** will qualify the **Super Jackpot**. The **Up/Down Bumper Post** remains up for about the first 10 seconds of ***13 Ball Play***, allowing the player to enjoy all of those balls!

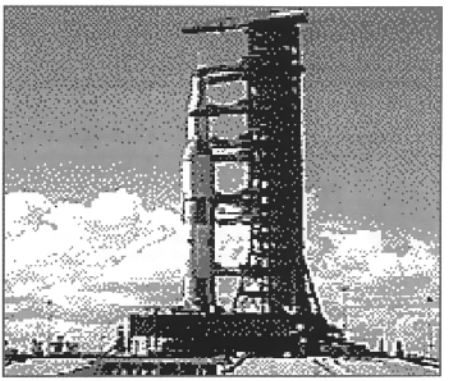
MULTIBALL&JACKPOTS

13b 13 BALL MULTIBALL SUPER JACKPOT:

If a set number of **Rocket Jackpots** are scored, the ramp will light for a timed **Super Jackpot**. After **Super Jackpot** is scored or the timer expires, the player continues with ***Regular Multiball*** rules — **4 (four) Jackpots** lit, etc.

13c ABORTING MULTIBALL

At ***Multiball*** start, the player has the option of turning the **Abort Handle** (Ball Launch) to bypass ***Multiball*** start. This option is for the advanced player who is trying to complete **B L A S T O F F** before starting ***Multiball***. The first time that abort is used, the **Countdown** will reset to [*1*]. If the player aborts again before starting ***Multiball***, the **Countdown** resets to [*2*], etc.



14 STARTING MISSIONS

Shooting the **Right Eject** or **Center Eject** when lit will start the flashing ***Apollo 13 Mission***. Mission objectives are listed below (14a - 14j). **Pop Bumpers** cycle flashing mission. Turn the **Abort Handle** (Ball Launch) to lock/unlock Missions. Missions may also be started from ***Skill Shot Select***.

14a ORBITER

A *Hurry-Up Countdown* starts on the **Left Orbit**. Shoot the **Left Orbit** to score the *Countdown*, then shoot the **Right Orbit** to triple scored value. This can be repeated until the ***Mission*** is over

14b CO_2

Shoot the **Spinner** to collect items to repair the CO_2 scrubbers before the CO_2 level reaches 20. Scoring all items scores a bonus based on switch closures during the ***Mission***.

14c MANUAL BURN

Shoot the **Flashing Shots** to fire thrusters to get the **Spacecraft** back on course. Flashing shots closer to the edges of the playfield provide more thrust than shots closer to the center.

14d ROCKET 2 BALL

Shoot the **Rocket** repeatedly for increasing **Jackpots**.

14e MOON'S GRAVITY

Shoot the **Ramp** 3 times and watch what happens next!

14f UNDER VOLT

Shoot a ***Battery Target*** to lock in a *Hurry-Up* value — all shots are lit for this value. ***Battery Targets*** add time.

14g LIFE SUPPORT

Shoot the ***Food & Water Targets*** to nourish Fred. 4 (four) shots earns a **Completion Bonus**.

14h DOCKING

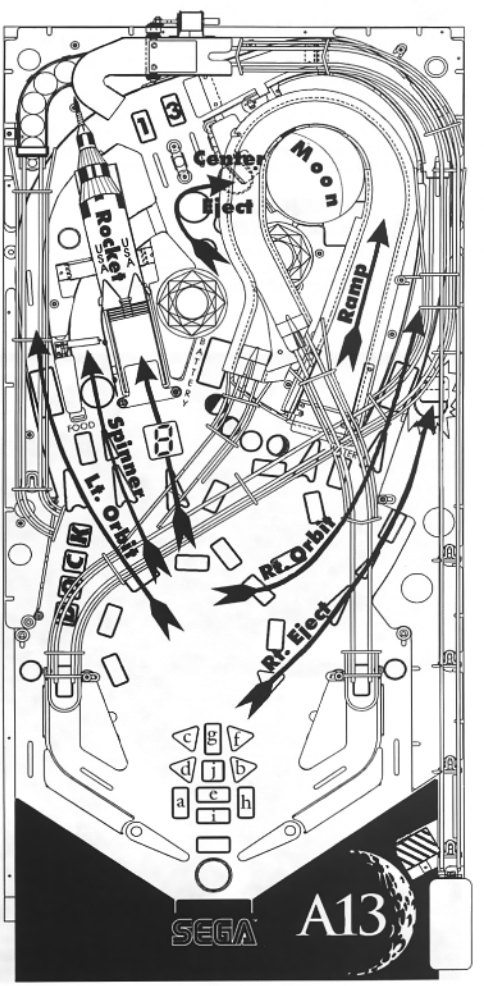
Shoot the roving ***D-O-C-K Targets*** for points and awards.

14i LITE EXTRA BALL

Light the **Extra Ball** at the **Right Eject**.

14j MASTER ALARM

The **Master Alarm** is not available until all other *Missions* have been played. All shots are lit for big points and the **Ramp** scores **Jackpots**. Score as many points as possible before the time expires.



MISSION CONTROL GAME RULE NOTES

COMBINATION SHOTS

Apollo 13 features several Multi-Way Combos. These Combo Shots involve natural sequences of key shots in the game. Several undocumented difficult combos may also be present.

END-OF-BALL BONUS CALCULATION

The **BONUS** is calculated as the sum of: **ROCKET BONUS + MOON BONUS + ORBIT BONUS + MISSION BONUS = TOTAL BONUS** There is no cap on the **TOTAL BONUS**. However, if all of the above are zero, a **TOTAL BONUS** of 1M will be awarded. There is no *Bonus Multiplier* in this game, though players can earn a **DOUBLE BONUS** (2X Bonus at the end of the current ball only). Normally, ***Bonus Totals*** will reset at the start of each new ball, but a **HOLD BONUS** is available from *Mystery*.

MISSION WARNING!

Just like any Mission, rules and point values are subject to change without notice. ***Call Houston if you have a problem!***

APOLLO 13 MISSION STATEMENT

Crew: Jim Lovell, Commander
Jack Swigert, Command Module Pilot
Fred Haise, Lunar Module Pilot
Launched: April 11, 1970
Splashdown: April 17, 1970
Mission: Third attempted lunar landing. At 55 hours, 54 minutes, and 53 seconds into the mission, a cryogenic tank explodes, causing a loss of breathable oxygen and power in the command-service module. Crew abandons ship and survive in the **LEM** until just a few hours before splashdown, when they return to the command module, jettison the **LEM**, and re-enter the atmosphere.

Portals™ Service Menu Introduction

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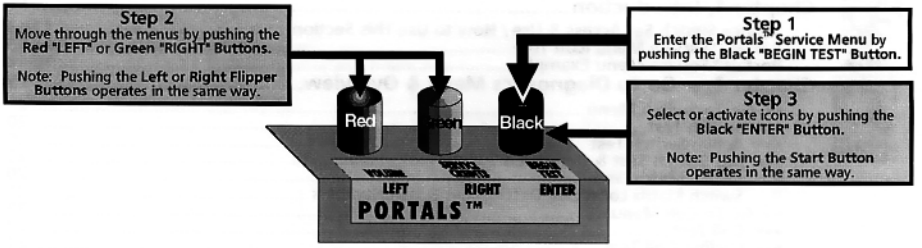
- ⌑ Added Information/Instruction.

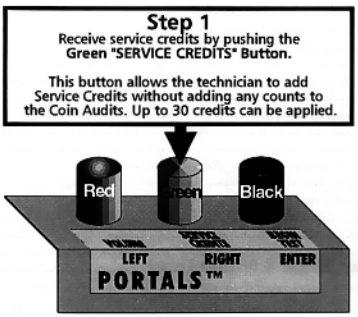
Service Switch Set (Red, Green & Black Buttons) Access & Use

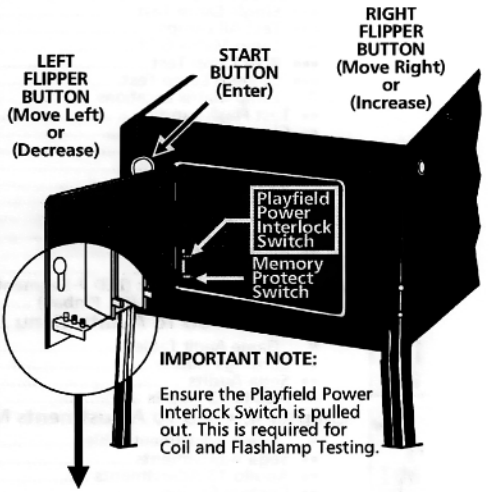
Open Coin Door and view Service Switch Set (see figures below). The Memory Protect Switch is now disabled; when changing adjustments, leave the coin door open, so changes can be made. **Please ensure the Playfield Power Interlock Switch is pulled out for Coil and Flashlamp testing (this is required).**

❶ *Entering* Portals™ Service Menu *(will not operate in Volume Mode):*

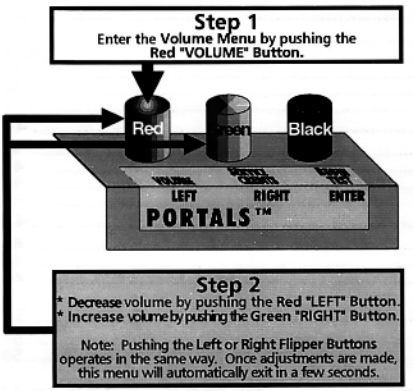

Step 2
Move through the menus by pushing the Red "LEFT" or Green "RIGHT" Buttons.
Note: Pushing the Left or Right Flipper Buttons operates in the same way.
Step 1
Enter the Portals™ Service Menu by pushing the Black "BEGIN TEST" Button.
Step 3
Select or activate icons by pushing the Black "ENTER" Button.
Note: Pushing the Start Button operates in the same way.
Red
Green
Black
LEFT
RIGHT
ENTER
PORTALS™

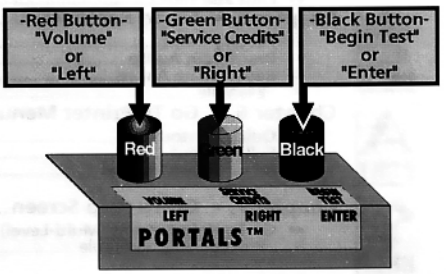
❷ *Adding* Service Credits *(will not operate in Service or Volume Modes):*


Step 1
Receive service credits by pushing the Green "SERVICE CREDITS" Button.
This button allows the technician to add Service Credits without adding any counts to the Coin Audits. Up to 30 credits can be applied.
Red
Green
Black
LEFT
RIGHT
ENTER
PORTALS™


LEFT FLIPPER BUTTON (Move Left) or (Decrease)
START BUTTON (Enter)
RIGHT FLIPPER BUTTON (Move Right) or (Increase)
Playfield Power Interlock Switch
Memory Protect Switch
IMPORTANT NOTE:
Ensure the Playfield Power Interlock Switch is pulled out. This is required for Coil and Flashlamp Testing.

❸ *Entering the* Volume Menu *(will not operate in Service Mode):*


Step 1
Enter the Volume Menu by pushing the Red "VOLUME" Button.
Red
Green
Black
LEFT
RIGHT
ENTER
PORTALS™
Step 2
* Decrease volume by pushing the Red "LEFT" Button.
* Increase volume by pushing the Green "RIGHT" Button.
Note: Pushing the Left or Right Flipper Buttons operates in the same way. Once adjustments are made, this menu will automatically exit in a few seconds.

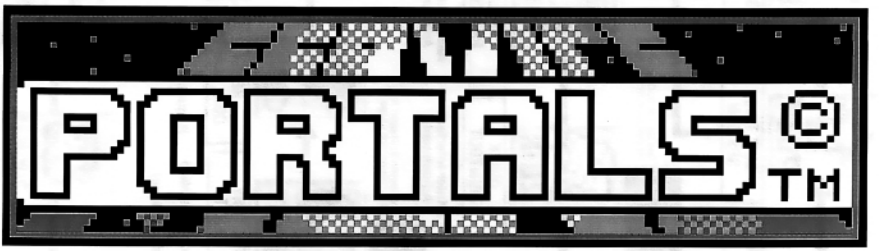


How to Use This Section

This section will cover all functions available in the **Portals™ Service Menu** in a *Step-By-Step* process. This section is divided into chapters which coincide with the **MAIN MENU**. The following pages in this chapter will instruct the operator on how to move through the menus. It's simple, easy and fun to use!

To get into the Service Menu Mode: • Power-up game (if not already) & open the Coin Door. • On the Coin Door is the Service Switch Set (**Red, Green & Black Buttons**). Push down the **Black "BEGIN TEST" Button**.

Looking at the Video Display you will momentarily see the introductory screen "Service Menu" with a satellite flying from right to left pulling a banner "Portals™ © 1995 SEGA PINBALL, INC.", followed by the **MAIN MENU**:

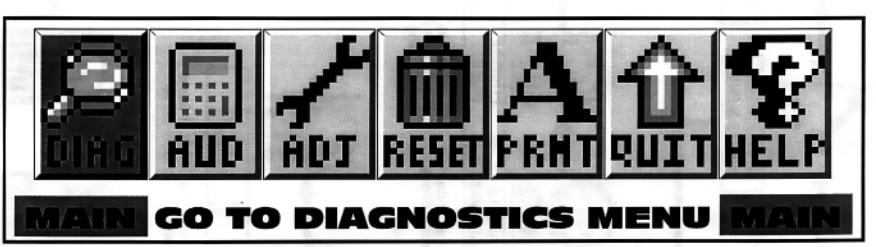


The Coin Door may be closed for security, however, please note with the Coin Door closed, the game's ***MEMORY PROTECT*** is enabled; ***meaning any changes that are made will be not be written to memory***. If changing adjustments is required, ensure the Coin Door is open.

Use the **Red "LEFT" & Green "RIGHT" Buttons** (or **Left & Right Flipper Buttons**) to move the selected **ICON** left or right, and the **Black "ENTER" Button** (or **Start Button**) to activate the selected **ICON**. The use of the Service Switch Set (**Red, Green, & Black Buttons**) *is required* in Switch Test or Active Switch Test, as the **Start & Flipper Buttons** are a part of this test.

For diagnostic purposes, be sure the ***Playfield Power Interlock Switch*** is pulled out so ***Playfield Power*** is not disabled.

The **MAIN MENU** now appears with the "DIAG" *Icon* (DIAGNOSTICS MENU) flashing:

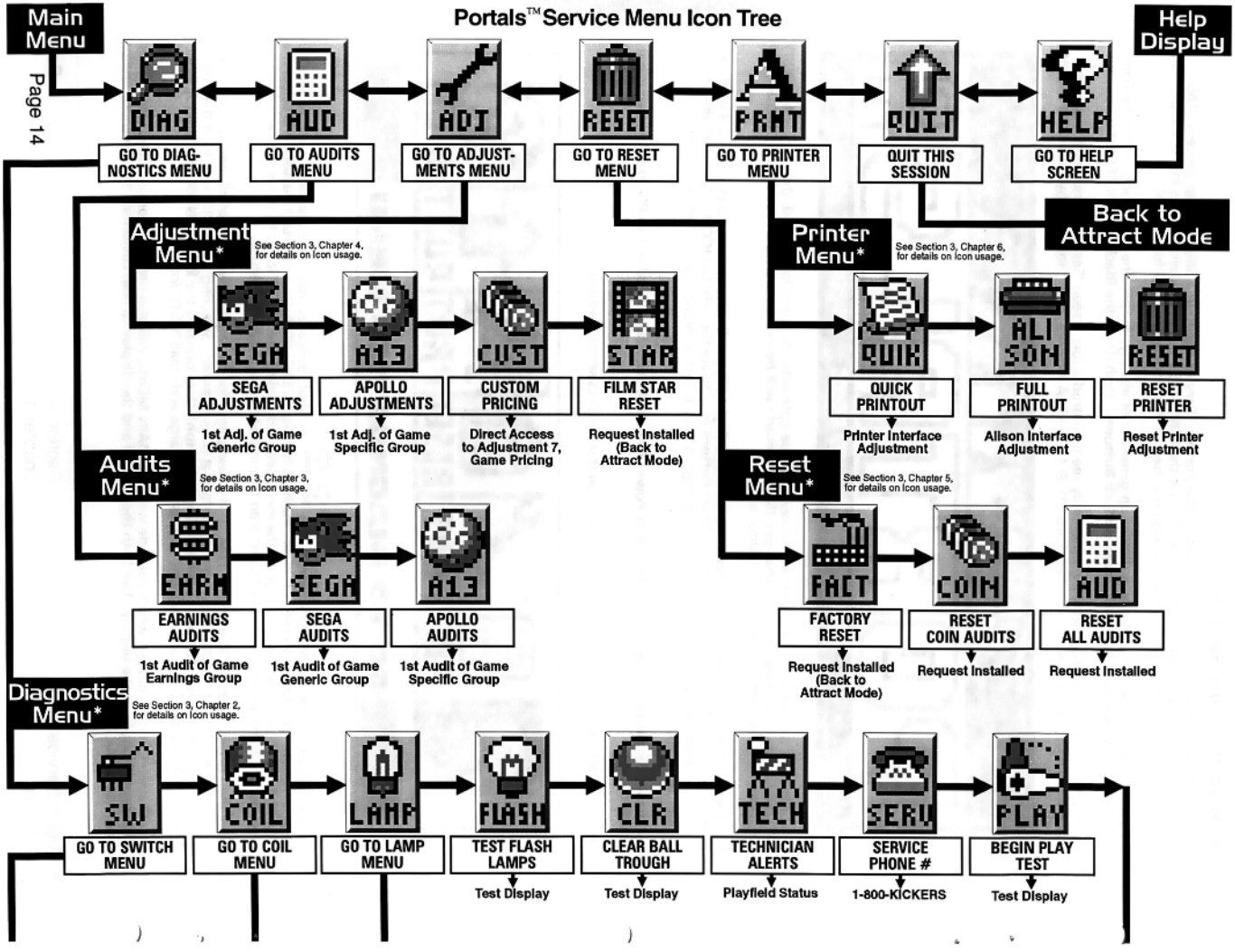


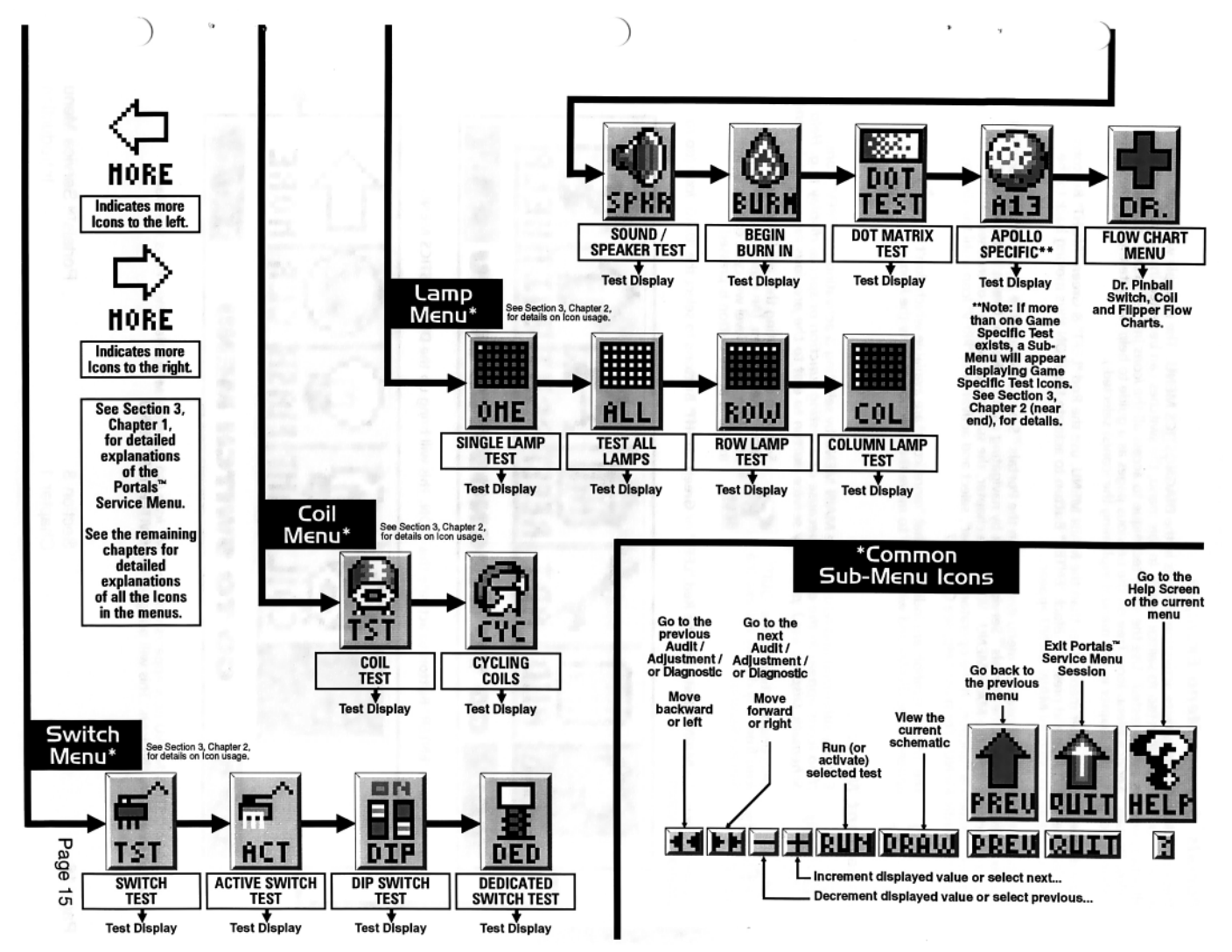
As the operator views the Menu Screen(s), the ⇦ MORE ⇨ MORE symbols indicates that there are more *Icons* to select in each direction. The *Icon* selected will blink. Pushing the **Black "ENTER" Button** (or **Start Button**) will select the *Icon* and the Menu Screen will change to the menu selected. Select the **"PREV"** *Icons* to move backwards through the menu levels. Select the **"QUIT"** *Icon* to completely exit the Service Mode.

View the **Portals™ Service Menu Icon Tree** on the next pages for a complete overview of all menus used in this system. View the last chapter (HELP) if more information is required. Selecting the "QUIT" *Icon* with the **Red "LEFT" or Green "RIGHT" Buttons** (or either **Flipper Button**), then pressing the **Black "ENTER" Button** (or **Start Button**) will exit the Service Mode. This applies to the large and small "QUIT" *Icons*.

The **chapters** in this **section**, which coincide with the **MAIN MENU**, will also provide more detailed information which could not fit in the display. Use both the manual and the display to help customize, troubleshoot and/or diagnose faults, if any.

Portals™ Service Menu Icon Tree




MORE
Indicates more Icons to the left.
MORE
Indicates more Icons to the right.
See Section 3, Chapter 1, for detailed explanations of the Portals™ Service Menu.
See the remaining chapters for detailed explanations of all the Icons in the menus.
SPKR
SOUND / SPEAKER TEST
Test Display
BURN
BEGIN BURN IN
Test Display
DOT TEST
DOT MATRIX TEST
Test Display
A13
APOLLO SPECIFIC**
Test Display
DR.
FLOW CHART MENU
Dr. Pinball Switch, Coil and Flipper Flow Charts.
**Note: If more than one Game Specific Test exists, a Sub-Menu will appear displaying Game Specific Test Icons. See Section 3, Chapter 2 (near end), for details.
Lamp Menu*
See Section 3, Chapter 2, for details on Icon usage.
ONE
SINGLE LAMP TEST
Test Display
ALL
TEST ALL LAMPS
Test Display
ROW
ROW LAMP TEST
Test Display
COL
COLUMN LAMP TEST
Test Display
Coil Menu*
See Section 3, Chapter 2, for details on Icon usage.
TST
COIL TEST
Test Display
CYC
CYCLING COILS
Test Display
Switch Menu*
See Section 3, Chapter 2, for details on Icon usage.
TST
SWITCH TEST
Test Display
ACT
ACTIVE SWITCH TEST
Test Display
DIP
DIP SWITCH TEST
Test Display
DED
DEDICATED SWITCH TEST
Test Display
*Common Sub-Menu Icons
Go to the previous Audit / Adjustment / or Diagnostic
Move backward or left
Go to the next Audit / Adjustment / or Diagnostic
Move forward or right
Run (or activate) selected test
View the current schematic
Go back to the previous menu
Exit Portals™ Service Menu Session
Go to the Help Screen of the current menu
PREV
QUIT
HELP
RUN
DRAW
Increment displayed value or select next...
Decrement displayed value or select previous...

Portals™ Service Menu Example

This example will demonstrate activation of *Icons* in the **DIAGNOSTICS MENU**. The example will show activation of the "SW" *Icon* (GO TO SWITCH MENU). In this menu, the switches can be tested individually and also all active switches can be tested. Use the same technique to access all the *Icons* in the **Portals™ Service Menu**. Follow **Portals™ Service Menu Icon Tree** on the previous pages as a guide to help navigate through the entire system (Also, go to the chapter in this manual explaining the icon(s) selected.).

If the display is in any other menu other than the **MAIN MENU**, use the **Red "LEFT"** & **Green "RIGHT" Buttons** to select the "PREV" *Icon* and press the **Black "ENTER" Button** to activate the **ICON** thus moving back to the previous menu. Do so until **MAIN MENU** appears.

Chapters 2 through 7 will cover all menu items within the **Portals™ Service Menu**. The *Icon* is shown preceding the text. Find the *Icon* in the **Portals™ Service Menu** by navigating with the **Red** or **Green Buttons**. Each chapter started is from the **MAIN MENU**. Within the chapter, the sub-menu's will be covered sequentially with their explanation & function. If the operator "*gets lost*", select and activate the "PREV" *Icon* until the display indicates **MAIN MENU**. For more help, see Chapter 7.

The "MORE" *symbols* are indicating that "*more icons*" are available which don't appear in the display and which way to move the selection to view the *Icons*.

Important Note:

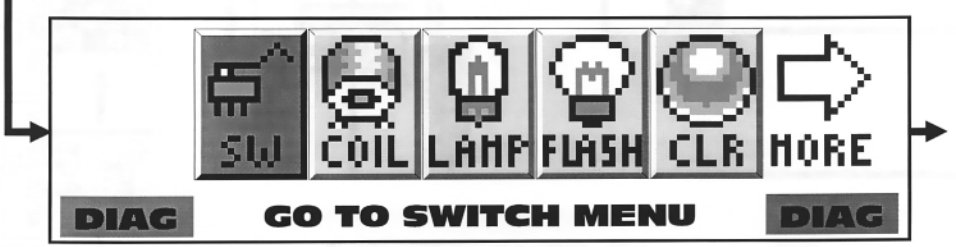
Exit any sub-menu and return to the **MAIN MENU** by selecting & activating the "PREV" *Icons*. ***If no Icons appear in the display because of a testing function or special display (e.g. Help, Schematic Display, etc.), press any service button to exit to the previous menu or sub-menu.***

Selecting & activating the "QUIT" *Icon* from any display will exit the *Service Session*.

Selecting & activating the "HELP" *Icon* will show a help screen. (An explanation of each *Mini-Icon* at that level will cycle continuously until any active button is pressed.)

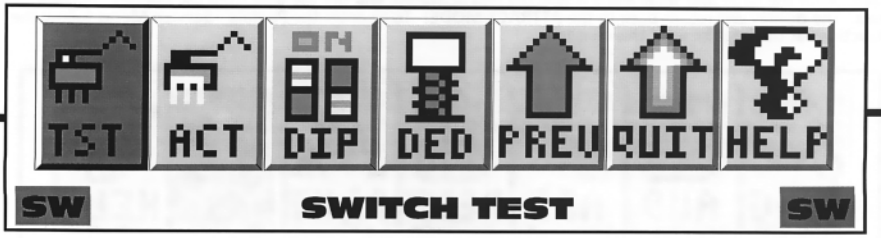
Example: From the **MAIN MENU**, use the **Red "LEFT"** or **Green "RIGHT" Buttons** to select the "DIAG" *Icon* (GO TO DIAGNOSTICS MENU).

Press the **Black "ENTER" Button** to activate this **ICON**. This will bring up the **DIAGNOSTICS MENU**.

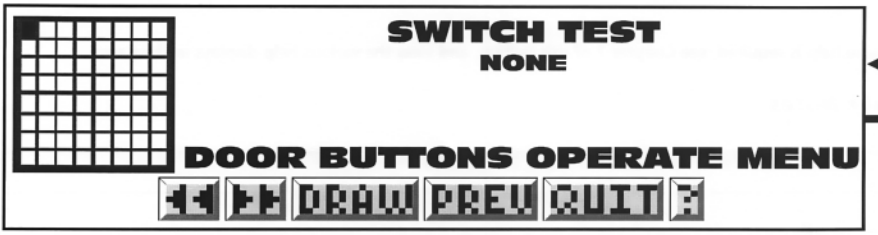


The **DIAGNOSTICS MENU** now appears with the "SW" *Icon* (GO TO SWITCH MENU) flashing. Press the **Black Button** to *activate* this icon. This will bring up the **SWITCH TEST MENU**.

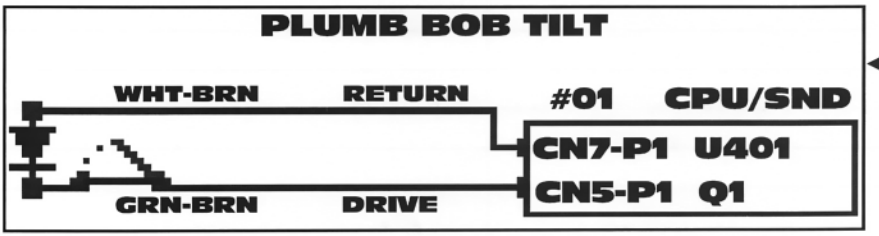
The **SWITCH TEST MENU** now appears with the "TST" *Icon* (SWITCH TEST) flashing:
Press the **Black "ENTER" Button** to *activate* this icon. This will bring up the **Switch Test Display**.



The **Switch Test Display** now appears.



All switches can be tested one at a time (When possible, use a pinball to close any playfield switches; rolling the ball at Stand-Up Targets or over/under switches is suggested. Use finger for all non-playfield switches.) As each switch is closed, the respective Switch Matrix Grid Position (1-64) will be lit. To view the schematic for the switch selected, press the **Red** or **Green Buttons** to select the "DRAW" *Icon*. Press the **Black Button** to *activate* this icon. This will bring up the **Switch Schematic Display** for the switch being closed.



An example is shown with Switch #01, Plumb Bob Tilt, selected. The display describes the switch in the Switch Matrix which includes the name of the switch, the Return (Row) Wire and the Drive (Column) Wire, drive transistor, the part number (not shown in the above example) and the "Pin-Outs" from the CPU/Sound Board.

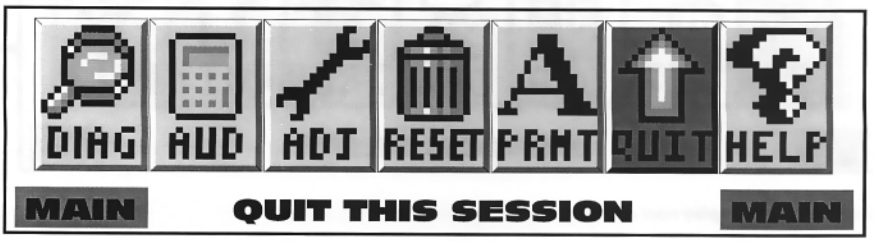
While in Switch or Active Switch Tests, the **Flipper & Start Buttons** are deactivated. Use the **Red "LEFT"**, **Green "RIGHT"** and/or **Black "ENTER" Buttons** to select and activate the **"MINI-ICONS"** at the bottom of the display. In Switch Test, if the "Left Arrow" or "Right Arrow" *Icon* is activated, the display will go to the previous tests (Active, Dip & Dedicated Switch Tests). Use the **Red** or **Green Buttons** to change the selected **ICON** to "PREV"*Icon*. Press the **Black "ENTER" Button** to go to the previous menu.

Note:
In **Dedicated Switch Test**, the **Flipper & Start Buttons** are to be used instead of the **Red**, **Green** & **Black Service Buttons**, as these buttons are deactivated for this test.

Exit out of the sub-menu by activating the big "PREV" *Icon* in the menu. This will bring up the **DIAGNOSTICS MENU**. The Switch Test Session is now complete. See the next page about exiting the **Portals™ Service Menu**.

Exiting the Portals™ Service Menu

All *Icons* will be covered in the chapters of this section with the exception of the "QUIT" *Icon*, in the **MAIN MENU**. Both the large and small *Icons* if selected and activated, will exit the user from the **Portals™ Service Menu**. The display will return back to the **ATTRACT MODE**! To re-enter the **Portals™ Service Menu** follow the instructions at the beginning of this chapter.



If more help is required, see Chapter 7 of this section, and view the various help displays in the game.

Your Notes

Go To Diagnostics Menu

Special Note: If the ***display flashes*** **"OPEN THE COIN DOOR"** the game is indicating that memory has been corrupted. This is caused be either failure in memory (e.g. batteries are dead and/or faulty **RAM**) or upon installation of updated version of game code. Opening the Coin Door will initiate a *Factory Restore*, by opening the ***Memory Protect Switch***. Check battery voltage at **CMOS RAM** with the power off.

Overview

The **Portals™ Service Menu System** provides tests for sounds, display, lamps, switches and coils. Each feature may be tested manually or automatically after entering the **Portals™ Service Menu** (see Chapter 1 of this section). Select the "DIAG" *Icon* from the **MAIN MENU** to go to the **DIAGNOSTICS MENU**. The automatic tests (e.g. Cycling Coils, Flash Lamps, etc.) may be used for a quick verification of automatic test functions and the manual tests (Begin Play Test, Single Lamp/All/Row/Column Tests, etc.) may be used for troubleshooting.

During game play, activation of switches and operation of coils with associated switches are monitored. If the CPU Board does not detect a switch transition ("Stuck Open" / "Stuck Closed") for 50 games, it is considered faulty. When operation of a coil should close or open a switch and does not, the coil is considered faulty. In the Attract Mode, faulty switches and coils (if any) are reported (Select the "TECH" *Icon*, Technician Alerts, from the **DIAGNOSTICS MENU**). Note that reporting of an unused switch does not constitute a problem and that a bad coil could mean that the associated switch requires adjustment.

GO TO DIAGNOSTICS MENU

With the game in the Attract Mode, open the Coin Door and press the **Black "BEGIN TEST" Button**. Select the "DIAG" *Icon* in the **MAIN MENU** with either **Flipper** or **Red "LEFT"** & **Green "Right" Buttons** (upon entry of the **Portals™ Service Menu**, the system defaults with the selection of the "DIAG" *Icon* flashing) and press the **Start** or **Black "ENTER" Buttons**. The **DIAGNOSTICS MENU** appears.

The "MORE" *symbols* are indicating that "*more icons*" are available which don't appear in the display and which way to move the selection to view the *Icons*.

Important Notes:

Exit any sub-menu and return to the **MAIN MENU** by selecting & activating the "PREV" *Icons*. If no *Icons* appear in the display because of a testing function or special display (e.g. "Help"), press any button to exit.

Selecting & activating the "QUIT" *Icon* from any display will exit the Service Session.

Selecting & activating the "HELP" *Icon* from any display will show a help screen. (An explanation of each *Mini-Icon* at that level will cycle continuously until any active button is pressed.)

In Diagnostics, selecting & activating the "-" or "+" *Icons* moves test forwards/backwards. Selecting & activating the "RUN" *Icon* repeats the test on the coil or flash lamp left off at. Selecting & activating the "ARROW" *Icons* moves between tests in the sub-menu. Selecting & activating the "DRAW" *Icon* will show the schematic for that switch or coil.

Some tests require navigation through the menu(s) and selection of the *Icons* with the **Red "LEFT", Green "RIGHT"** and **Black "ENTER" Buttons**. This is required is Switch and Active Switch Tests, as the **Flipper** and **Start Buttons** are a part of the test.

In Coil Test, ensure the **Power Interlock Switch** is pulled out. (See ***Access & Use*** of Chapter 1 of this section for the location.) If the switch is not pulled out, the coils and flash lamps cannot be tested (32v DC and 50v DC are disabled). Closing the Coin Door will automatically reset this switch. Coils and Flash Lamps are checked manually in Coil Test. To automatically check coils, go to Cycling Coils from the **COIL TEST MENU**. To automatically check flash lamps, go to Flash Lamp Test, from the **DIAGNOSTICS MENU**.

GO TO SWITCH MENU

From the **DIAGNOSTICS MENU**, select the "SW" *Icon* with either **Red "LEFT"** or **Green "RIGHT" Button** and press the **Black "ENTER" Button**. Switches are configured in an 8 x 8 Matrix of Columns (Switch Drives) and Rows (Switch Returns) with up to 64 switches possible. The Switch Test Menu consists of two parts: Switch Test & Active Switches. (**Flipper & Start Buttons** are deactivated during Sw. Tests.)

Switch Test

To initiate, from the **SWITCH MENU**, select the "TST" *Icon* with the **Red** or **Green Button** & press the **Black Button**. In Switch Test, close each switch and observe the display. The display will describe the switch in the Switch Matrix, which includes the switch name, Return (Row) Wire, Drive (Column) Wire, Part Nº, and the "Pin-Outs" from the CPU/SOUND Board. When the switch is released, the information of the last switch closed will remain in the display until another switch is closed or the test is exited. To view the switch schematic, select the mini "DRAW" *Icon* with the **Red** or **Green Button** & press the **Black Button**.

Active Switch Test

To initiate, from the **SWITCH MENU**, select the "ACT" *Icon* with either **Red** or **Green Button** & press the **Black Button**. If still in a previous test, select the "PREV" *Icon* to return to Switch Menu or selecting either of the "ARROW" *Icons* will move through the tests. If any switches are stuck closed (or made from the presence of a pinball), the display sequences through the switch names, Return (Row) Wire, Drive (Column) Wire, drive transistor, Part Nº, and the "Pin-Outs" from the CPU/SOUND Board. This cycle continues until all switches are cleared or until the test is exited.

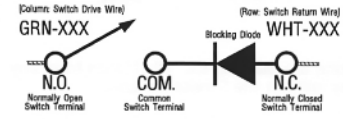
Dip Switch Test

To initiate, from the **SWITCH MENU**, select the "DIP" *Icon* with either **Red** or **Green Button** & press the **Black Button**. The display will indicate the Dip Switch Positions & the country setting the game is set to (e.g. USA, Germany, England, etc.). *REFERENCE THE BEGINNING OF THIS MANUAL FOR DIP SWITCH SETTINGS.*

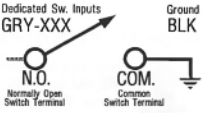
Dedicated Switch Test

To initiate, from the **SWITCH MENU**, select the "DED" *Icon* with either **Flipper Button** & press the **Start Button** (The service switches are deactivated during this test.). The display will describe the switch which includes the switch name, Return (Row) Wire, Column Wire, Part Nº, and the "Pin-Outs" from the CPU/SOUND Board.

Typical Switch Schematic & Side View



Dedicated Switch Schematic



SWITCH MATRIX GRID

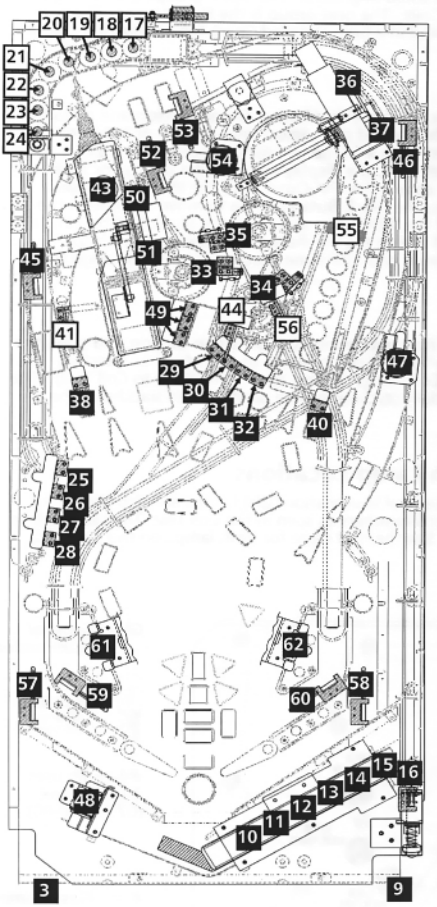
Column (Drive) / Row (Return)	1 Q1 GRN-BRN CN5-1	2 Q2 GRN-RED CN5-3	3 Q3 GRN-ORG CN5-4	4 Q4 GRN-YEL CN5-5	5 Q5 GRN-BLK CN5-6	6 Q6 GRN-BLU CN5-7	7 Q7 GRN-VIO CN5-8	8 Q8 GRN-GRY CN5-9
1 WHT-GRY CN7-1	PLUMB BOB TILT 1	ABORT HANDLE BALL LAUNCH 9	8-BALL LOCK #1 (TOP) 17	D-O-C-(K) 4-BANK S-U 25	LEFT TURBO BUMPER 33	SPINNER 41	BATTERY 3-BANK S-U (ALL 3) 49	LEFT OUTLANE 57
2 WHT-VIO CN7-2	4TH COIN SLOT 2	5-BALL TROUGH #1 (LEFT) 10	8-BALL LOCK #2 18	D-O-(C)-K 4-BANK S-U 26	BOTTOM TURBO BUMPER 34	NOT USED 42	ROCKET HOME POSITION 50	RIGHT OUTLANE 58
3 WHT-BLU CN7-3	START BUTTON 3	5-BALL TROUGH #2 11	8-BALL LOCK #3 19	D-(O)-C-K 4-BANK S-U 27	RIGHT TURBO BUMPER 35	ROCKET BALL EJECT 43	ROCKET UP POSITION 51	LEFT RETURN LANE 59
4 WHT-GRN CN7-5	RIGHT COIN SLOT 4	5-BALL TROUGH #3 12	8-BALL LOCK #4 20	(D)-O-C-K 4-BANK S-U 28	MOON HOME POSITION 36	RIGHT RAMP EXIT LEFT 44	LEFT TOP LANE 52	RIGHT RETURN LANE 60
5 WHT-YEL CN7-6	CENTER COIN SLOT / DBA 5	5-BALL TROUGH #4 13	8-BALL LOCK #5 21	MOON 4-BANK S-U (LEFT) 29	MOON FORWARD POSITION 37	LEFT ORBIT 45	RIGHT TOP LANE 53	LEFT SLINGSHOT 61
6 WHT-ORG CN7-7	LEFT COIN SLOT 6	5-BALL TROUGH #5 (RIGHT) 14	8-BALL LOCK #6 22	MOON 4-BANK S-U (MID-LT) 30	FOOD SINGLE STAND-UP 38	RIGHT ORBIT 46	CENTER BALL EJECT 54	RIGHT SLINGSHOT 62
7 WHT-RED CN7-8	SLAM TILT 7	5-BALL TROUGH VUK OPTO 15	8-BALL LOCK #7 23	MOON 4-BANK S-U (MID-RT) 31	NOT USED 39	RIGHT BALL EJECT 47	RIGHT RAMP ENTER 55	LT FLIPPER BUTTON VIA Q7 (ON SSFB) 63
8 WHT-BRN CN7-9	NOT USED 8	SHOOTER LANE 16	8-BALL LOCK #8 (BOTTOM) 24	MOON 4-BANK S-U (RIGHT) 32	WATER SINGLE STAND-UP 40	SUPER VUK (UNDER ARCH) 48	RIGHT RAMP EXIT RIGHT 56	RT FLIPPER BUTTON VIA Q5 (ON SSFB) 64

Dedicated Switches

IC U206 INPUTS	GND / Ground BLK CN6-1
1 GRY-BRN CN6-2	NOT USED DS-1
2 GRY-RED CN6-3	NOT USED DS-2
3 GRY-ORG CN6-4	NOT USED DS-3
4 GRY-YEL CN6-6	NOT USED DS-4
5 GRY-GRN CN6-7	NOT USED DS-5
6 GRY-BLU CN6-8	Normal: Volume In Test: Left RED BUTTON DS-6
7 GRY-VIO CN6-9	Normal: Service Credits In Test: Right GRN BUTTON DS-7
8 GRY-BLK CN6-10	Normal: Begin Test In Test: Enter BLK BUTTON DS-8

Switch Matrix Descriptions with Part Numbers and Locations †

The switch locations correspond with the Switch Nº in the table below and the Switch Maxtrix Grid.



Legend Note:

☐ = Switches located above playfield.

■ = Switches located below playfield.

The following switches are located in the cabinet and are not noted in the diagram above:

1 2 4 5 6 7 63 64

The following switches are not used:

8 39 42

Sw. Nº	Col. Nº	Row Nº	Switch Matrix Description	Part Nº
1	1	1	* PLUMB BOB TILT (See Section 4, Chapter 1)	
2	1	2	* 4TH COIN SLOT (On Coin Door)	— - — - —
3	1	3	START BUTTON (Left of Coin Door) RED	500-5026-07
4	1	4	* RIGHT COIN SLOT (On Coin Door)	180-5024-00
5	1	5	* CENTER COIN SLOT / DBA	180-5024-00
6	1	6	* LEFT COIN SLOT (On Coin Door)	180-5024-00
7	1	7	* SLAM TILT	180-5022-00
8	1	8	Not Used	— - — - —
9	2	1	ABORT HANDLE BALL LAUNCH	180-5061-00
10	2	2	5-BALL TROUGH #1 (LEFT)	180-5119-00
11	2	3	5-BALL TROUGH #2	180-5119-00
12	2	4	5-BALL TROUGH #3	180-5119-00
13	2	5	5-BALL TROUGH #4	180-5119-00
14	2	6	5-BALL TROUGH #5 (RIGHT)	180-5119-00
15	2	7	#5-BALL TROUGH VUK OPTO (TRANS) (REC)	520-5124-00 520-5125-00
16	2	8	SHOOTER LANE (AUTO BALL LAUNCH)	515-6514-00
17	3	1	8-BALL LOCK TROUGH #1 (TOP)	181-5000-00
18	3	2	8-BALL LOCK TROUGH #2	
19	3	3	8-BALL LOCK TROUGH #3	*Note: All 8 positions are included in this special membrane switch.*
20	3	4	8-BALL LOCK TROUGH #4	
21	3	5	8-BALL LOCK TROUGH #5	
22	3	6	8-BALL LOCK TROUGH #6	
23	3	7	8-BALL LOCK TROUGH #7	
24	3	8	8-BALL TROUGH #8 (BOTTOM)	
25	4	1	D-O-C-(K) 4-BANK STAND-UP (TOP)	515-5966-02
26	4	2	D-O-(C)-K 4-BANK STAND-UP (MID-TOP)	515-5966-02
27	4	3	D-(O)-C-K 4-BANK STAND-UP (MID-BOT)	515-5966-02
28	4	4	(D)-O-C-K 4-BANK STAND-UP (BOTTOM)	515-5966-02
29	4	5	MOON 4-BANK STAND-UP (LEFT)	515-5967-08
30	4	6	MOON 4-BANK STAND-UP (MIDDLE-LEFT)	515-5967-08
31	4	7	MOON 4-BANK STAND-UP (MIDDLE-RIGHT)	515-5967-08
32	4	8	MOON 4-BANK STAND-UP (RIGHT)	515-5967-08
33	5	1	LEFT TURBO BUMPER	180-5015-03
34	5	2	BOTTOM TURBO BUMPER	180-5015-03
35	5	3	RIGHT TURBO BUMPER	180-5015-03
36	5	4	MOON HOME POSITION	180-5019-00
37	5	5	MOON FORWARD POSITION	180-5019-00
38	5	6	FOOD SINGLE STAND-UP (LEFT)	515-5967-04
39	5	7	Not Used	— - — - —
40	5	8	WATER SINGLE STAND-UP (RIGHT)	515-5967-05
41	6	1	SPINNER	180-5010-04
42	6	2	Not Used	— - — - —
43	6	3	ROCKET BALL EJECT	180-5116-00
44	6	4	RIGHT RAMP EXIT LEFT	515-6469-00
45	6	5	LEFT ORBIT	500-5707-00
46	6	6	RIGHT ORBIT	500-5707-00
47	6	7	RIGHT BALL EJECT	180-5116-00
48	6	8	SUPER VUK (UNDER ARCH)	180-5116-00
49	7	1	BATTERY 3-BANK STAND-UP (ALL 3)	515-5967-06
50	7	2	ROCKET HOME POSITION	180-5052-00
51	7	3	ROCKET UP POSITION	180-5052-00
52	7	4	LEFT TOP LANE	500-5707-00
53	7	5	RIGHT TOP LANE	500-5707-00
54	7	6	CENTER BALL EJECT	180-5116-00
55	7	7	RIGHT RAMP ENTER	180-5090-00
56	7	8	RIGHT RAMP EXIT RIGHT	515-6469-00
57	8	1	LEFT OUTLANE	500-5707-00
58	8	2	RIGHT OUTLANE	500-5707-00
59	8	3	LEFT RETURN LANE	500-5707-00
60	8	4	RIGHT RETURN LANE	500-5707-00
61	8	5	LEFT SLINGSHOT	180-5054-00
62	8	6	RIGHT SLINGSHOT	180-5054-00
63	8	7	* LT FLIPPER PWR SW (BUTTON VIA Q7)	180-5122-00
64	8	8	* RT FLIPPER PWR SW (BUTTON VIA Q5)	180-5122-00

GO TO COIL MENU

From the **DIAGNOSTICS MENU**, select the "COIL" *Icon* with either **Red "LEFT"** or **Green "RIGHT" Button** and press the **Black "ENTER" Button**. The coils are listed in groups. The first 2 groups are the High Current Coils. The next group is the Low Current Coils. The next group is the Flash Lamps. The remaining coils are special coils. These coils are listed in a Coils Detailed Chart Table following the Playfield Coil & Flash Lamp Locations.

Coil Test

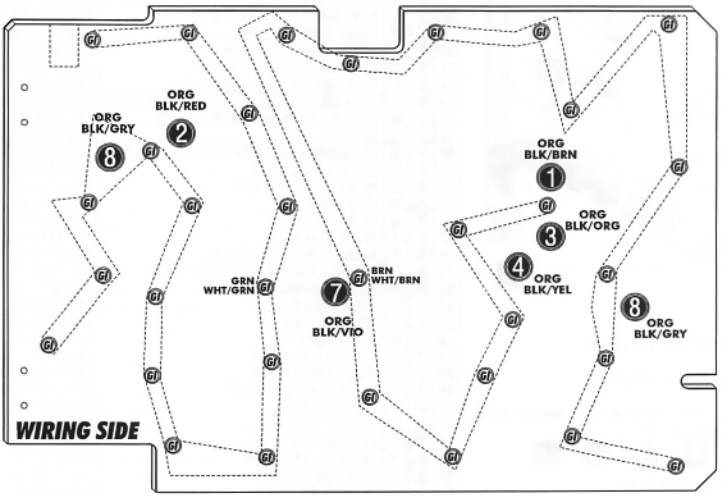
To initiate, from the **COIL MENU**, select the "TST" *Icon* with either **Red** or **Green Button** and press the **Black Button**. Ensure the **Power Interlock Switch** is pulled out. Select either the "-" or "+" *Icons*. Start with the "+" *Icon* to start the manual Coil Test from #1 (The test runs through #1 - #34+). Press the **Black Button** on the "+" *Icon*, as each coil is selected, the display will describe the coil or flash lamp name with the corresponding number, the wire with colors, the "Pin-Outs" from the I/O Power Driver Board, the coil voltage and gauge-turns (e.g. 23-800). Press the **Black Button** again to move forward in the test. To test and view a particular coil or flash lamp, select the "RUN" *Icon* and press the **Black Button**. Each time the **Black Button** is pushed, the coil or flash lamp will fire on the playfield and/or backbox, with the display indicating the coil or flash lamp information. Continue with the same procedure to run through the entire test.

Cycling Coil Test

To initiate, from the **COIL MENU**, select the "CYC" *Icon* with either **Red** or **Green Button** and press the **Black Button**.. If still in a previous test, select the "PREV" *Icon* to return to Coil Menu or selecting either of the "ARROW" *Icons* will move to Cycling Coil Test (selecting again will return to Coil Test). The test pulses each regular coil or flash lamp sequentially (cycling) on the playfield and backbox. The display indicates "CYCLING COILS".

Backbox Insert Flash Lamp Locations

Below are the flash lamp locations in the Backbox Insert (General Illumination (GIs) Lamps are also shown for reference). The flash lamp locations correspond with the coil numbers as seen in the Coil Test. The table below indicates the numbers for the flash lamps in the backbox. See the next page for flash lamps on the playfield.



GI = General Illumination

#44 Bulb
(Bayonet)
165-5000-44

#44 Bulb uses 2-Lug Socket (077-5000-00).

 # = Flash Lamp (FLAMP)

#89 Bulb
(Bayonet)
165-5000-89

#89 Bulb uses a Stand-Up Short Socket (077-5101-00).

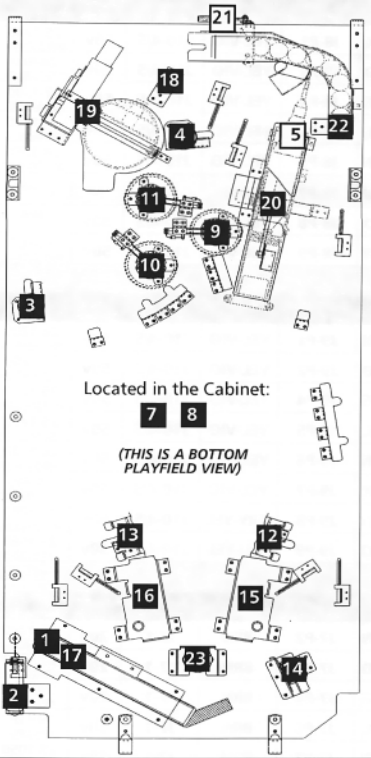
Type	Qty.
FLAMP 1	Insert X1
FLAMP 2	Insert X1

Type	Qty.
FLAMP 3	Insert X1
FLAMP 4	Insert X1

Type	Qty.
FLAMP 5	Not used.
FLAMP 6	Not used.

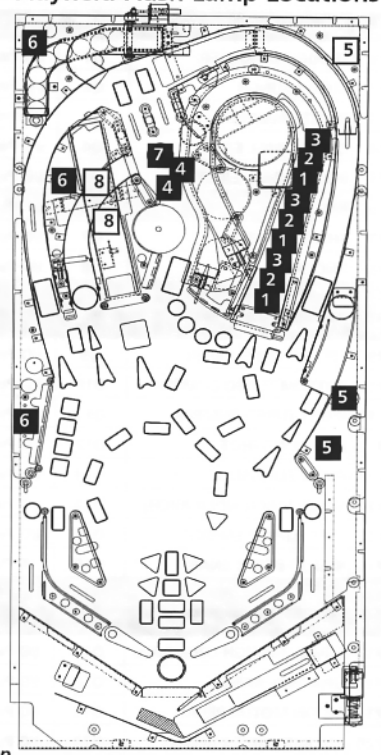
Type	Qty.
FLAMP 7	Insert X1
FLAMP 8	Insert X2

Playfield Coil Locations



Type	Coil Description
COIL 1	Trough Up-Kicker (VUK) (24-940)
COIL 2	Auto Launch 50v (24-940)
COIL 3	Right Ball Eject (27-1500)
COIL 4	Center Ball Eject (27-1500)
COIL 5	Rocket Ball Eject (28-1050)
COIL 6	Not Used
COIL 7	Shaker Motor
COIL 8	Knocker (23-800)
COIL 9	Left Turbo Bumper (23-700)
COIL 10	Bottom Turbo Bumper (23-700)
COIL 11	Right Turbo Bumper (23-700)
COIL 12	Left Slingshot (23-800)
COIL 13	Right Slingshot (23-800)
COIL 14	Super VUK (Under Arch) 50v (24-940)
COIL 15	Left Flipper Enable
COIL 16	Right Flipper Enable
COIL 17	5-Ball Trough Lock Ball (25-1240)
COIL 18	Up/Down Ramp (27-1500)
COIL 19	Moon Motor Relay
COIL 20	Rocket Motor Relay
COIL 21	Trap Door (28-1050)
COIL 22	8 Ball Lock Plunger (27-1500)
COIL 23	Up/Down Post (27-1500)
COIL 24	Not Used

Playfield Flash Lamp Locations



Flash Lamp (FLAMP)

#89 Bulb
(Bayonet)
165-5000-89

#906 Bulb
(Wedge Base)
165-5004-00

Type	Flash Lamps Description & Qty.
FLAMP 1	RAMP X3 (Under Right Ramp), INSERT X1
FLAMP 2	RAMP X3 (Under Right Ramp), INSERT X1
FLAMP 3	RAMP X3 (Under Right Ramp), INSERT X1
FLAMP 4	POPS X2, BP (Backpanel) X1, INSERT X1
FLAMP 5	UPR-RT X1, LWR-RT X2, BP (Backpanel) X1
FLAMP 6	UPR-LT X1, LWR-LT X1, BP (Backpanel) X1
FLAMP 7	POPS X1, BP (Backpanel) X1, INSERT X1
FLAMP 8	ROCKET X2, INSERT X2

See previous pg. for Backbox Insert Flash Lamp Locations.

Legend Note:

☐ Coils or Flash Lamps located above playfield.

■ Coils or Flash Lamps located below playfield.

The following coils are not used:

6 24

COILS DETAILED CHART TABLE

High Current Coils Group 1		Drive Transistor (D.T.)	Driver Ouput Board	D.T. Control Line Color	D.T. Control Line Connect	Power Line Color	Power Line Connnection	Power Voltage	Coil GA/Turn
#1	TROUGH UP-KICKER	Q1	I/O Pwr. Drvr.	BRN-BLK	J8-P1	YEL-VIO	J10-4/5	50v	25-1240 090-5036-01
#2	AUTO LAUNCH	Q2	I/O Pwr. Drvr.	BRN-RED	J8-P3	YEL-VIO	J10-4/5	50v	24-940 090-5036-01
#3	RIGHT BALL EJECT	Q3	I/O Pwr. Drvr.	BRN-ORG	J8-P4	YEL-VIO	J10-4/5	50v	27-1500 090-5004-01
#4	CENTER BALL EJECT	Q4	I/O Pwr. Drvr.	BRN-YEL	J8-P5	YEL-VIO	J10-4/5	50v	27-1500 090-5004-01
#5	ROCKET BALL EJECT	Q5	I/O Pwr. Drvr.	BRN-GRN	J8-P6	YEL-VIO	J10-4/5	50v	28-1050 090-5046-00
#6	NOT USED	Q6	I/O Pwr. Drvr.	BRN-BLU	J8-P7	BRN	— - —	---	— - —
#7	SHAKER MOTOR	Q7	I/O Pwr. Drvr.	BRN-VIO	J8-P8	YEL-VIO	J10-4/5	50v	N/A
#8	KNOCKER	Q8	I/O Pwr. Drvr.	BRN-GRY	J8-P9	YEL-VIO	J10-4/5	50v	23-800 090-5001-01

High Current Coils Group 2		Drive Transistor (D.T.)	Driver Ouput Board	D.T. Control Line Color	D.T. Control Line Connect	Power Line Color	Power Line Connnection	Power Voltage	Coil GA/Turn
#9	LEFT TURBO BUMPER	Q9	I/O Pwr. Drvr.	BLU-BRN	J9-P1	YEL-VIO	J10-4/5	50v	26-1200 090-5044-00
#10	BOTTOM TURBO BUMPER	Q10	I/O Pwr. Drvr.	BLU-RED	J9-P2	YEL-VIO	J10-4/5	50v	26-1200 090-5044-00
#11	RIGHT TURBO BUMPER	Q11	I/O Pwr. Drvr.	BLU-ORG	J9-P4	YEL-VIO	J10-4/5	50v	26-1200 090-5044-00
#12	LEFT SLINGSHOT	Q12	I/O Pwr. Drvr.	BLU-YEL	J9-P5	YEL-VIO	J10-4/5	50v	26-1200 090-5044-00
#13	RIGHT SLINGSHOT	Q13	I/O Pwr. Drvr.	BLU-GRN	J9-P6	YEL-VIO	J10-4/5	50v	26-1200 090-5044-00
#14	SUPER VUK (UNDER ARCH)	Q14	I/O Pwr. Drvr.	BLU-BLK	J9-P7	YEL-VIO	J10-4/5	50v	24-940 090-5036-01
#15	LEFT FLIPPER ENABLE	Q15	I/O Pwr. Drvr.	ORG-GRY	J9-P8	GRY-YEL	J10-4/5	50v	22-1080 090-5032-00
#16	RIGHT FLIPPER ENABLE	Q16	I/O Pwr. Drvr.	ORG-VIO	J9-P9	BLU-YEL	J10-4/5	50v	22-1080 090-5032-00

Low Current Coils Group 1		Drive Transistor (D.T.)	Driver Ouput Board	D.T. Control Line Color	D.T. Control Line Connect	Power Line Color	Power Line Connnection	Power Voltage	Coil GA/Turn
#17	5-BALL TROUGH LOCK BALL	Q17	I/O Pwr. Drvr.	VIO-BRN	J7-P2	BRN	J7-1	20v	25-1240 090-5036-01
#18	UP/DOWN RAMP	Q18	I/O Pwr. Drvr.	VIO-RED	J7-P3	BRN	J7-1	20v	27-1500 090-5004-01
#19	MOON MOTOR RELAY	Q19	I/O Pwr. Drvr.	VIO-ORG	J7-P4	BRN	J7-1	20v	24V DC 10A DPDT
#20	ROCKET MOTOR RELAY	Q20	I/O Pwr. Drvr.	VIO-YEL	J7-P6	BRN	J7-1	20v	24V DC 10A DPDT
#21	TRAP DOOR	Q21	I/O Pwr. Drvr.	VIO-GRN	J7-P7	BRN	J7-1	20v	28-1050 090-5046-00
#22	8 BALL LOCK PLUNGER	Q22	I/O Pwr. Drvr.	VIO-BLU	J7-P8	BRN	J7-1	20v	27-1500 090-5004-01
#23	UP/DOWN POST	Q23	I/O Pwr. Drvr.	VIO-BLK	J7-P9	BRN	J7-1	20v	27-1500 090-5004-01
#24	NOT USED	Q24	I/O Pwr. Drvr.	VIO-GRY	J7-P10	BRN	— - —	---	— - —

FLIPPER COILS

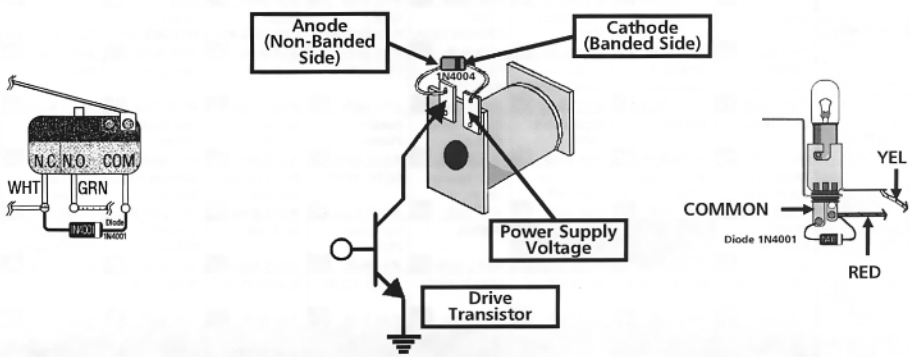
SSFB №	Flipper Coil	Cabinet Switch	Switch Drive	Switch Return	E.O.S.	GND	Flipper 50vDC Power	Flipper 8vAC Hold	Flipper Coil Output
SSFB 1	Lwr. Rt. Flipper 22-1080	BLU-VIO SSFB CN1-7	GRN-GRY CPU CN8-9 TO SSFB CN1-4	WHT-GRY CPU CN10-1 TO SSFB CN1-3	BRN-VIO RT. EOS SW. TO CN1-1	BLK CPU CN5 TO CN1-6	BLK-WHT PPB J7-1, -5 to SSFB CN2-11, 12	GRY-GRN-GRY P/S CN1-10, -11, to SSFB CN2-9, 10	50v Q2, Q3, | 8vAC SR1 CN2-7, 8
SSFB 1	Lwr. Lt. Flipper 22-1080	BLU-GRY SSFB CN1-10	GRN-GRY CPU CN8-9 TO SSFB CN1-4	WHT-VIO CPU CN10-2 TO SSFB CN1-5	BRN-GRY LT. EOS SW. TO CN1-9	BLK CPU CN5 TO CN1-6	BLK-WHT PPB J7-1, -5 to SSFB CN2-11, 12	GRY-GRN-GRY P/S CN1-10, -11, to SSFB CN2-9, 10	50v Q2, Q10, | 8vAC S R2 CN2-4, 5

Coils Detailed Chart Table Continued

Flash Lamps (FLAMP)			Drive Transistor (D.T.)	Driver Ouput Board	D.T. Control Line Color	D.T. Control Line Connect	Power Line Color	Power Line Connection	Power Voltage	Bulb Type
#1	Under Right Ramp	X3	Q25	I/O Pwr. Drvr.	BLK-BRN	J6-P1	ORG	J6-P10	20v	3X #906 165-5004-00 1X #89 165-5000-89
	Backbox Insert	X1								
#2	Under Right Ramp	X3	Q26	I/O Pwr. Drvr.	BLK-RED	J6-P2	ORG	J6-P10	20v	3X #906 165-5004-00 1X #89 165-5000-89
	Backbox Insert	X1								
#3	Under Right Ramp	X3	Q27	I/O Pwr. Drvr.	BLK-ORG	J6-P3	ORG	J6-P10	20v	3X #906 165-5004-00 1X #89 165-5000-89
	Backbox Insert	X1								
#4	Pop Bumper Area	X2	Q28	I/O Pwr. Drvr.	BLK-YEL	J6-P4	ORG	J6-P10	20v	4X #89 165-5000-89
	Backpanel	X1								
	Backbox Insert	X1								
#5	Upper Right Playfield	X1	Q29	I/O Pwr. Drvr.	BLK-GRN	J6-P5	ORG	J6-P10	20v	4X #89 165-5000-89
	Lower Right Playfield	X2								
	Backpanel	X1								
#6	Upper Left Playfield	X1	Q30	I/O Pwr. Drvr.	BLK-BLU	J6-P6	ORG	J6-P10	20v	3X #89 165-5000-89
	Lower Left Playfield	X1								
	Backpanel	X1								
#7	Pop Bumper Area	X1	Q31	I/O Pwr. Drvr.	BLK-VIO	J6-P7	ORG	J6-P10	20v	3X #89 165-5000-89
	Backpanel	X1								
	Backbox Insert	X1								
#8	Rocket Area	X2	Q32	I/O Pwr. Drvr.	BLK-GRY	J6-P8	ORG	J6-P10	20v	4X #89 165-5000-89
	Backbox Insert	X2								

Aux. Data Line			Driver Ouput Board LOC: Under Playfield	D.T. Control Line Color	D.T. Control Line Connect	Power Line Color	Power Line Connection	Power Voltage
#1	Magnet Grab		Magnet Driver	BLUE	P4	YEL-VIO	P3	50v
#2	Magnet Hold		Magnet Driver	BLUE	P4	YEL-VIO	P3	50v

TYPICAL SWITCH, COIL & LAMP WIRING



GO TO LAMP MENU

From the **DIAGNOSTICS MENU**, select the "LAMP" *Icon* with either **Red "LEFT"** or **Green "RIGHT" Button** and press the **Black "ENTER" Button**. Controlled lamps are configured in and 8 x 8 Matrix of Columns (Lamp Drives) and Rows (Lamp Returns) with up to 64 lamps possible. The Lamp Test Menu consists of four parts: Single Lamp Test, Test All Lamps, Row Lamp Test and Column Lamp Test.

Single Lamp Test

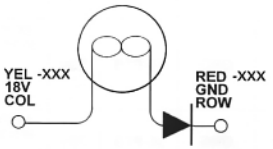
To initiate, from the **LAMP MENU**, select the "ONE" *Icon* with either **Red** or **Green Button** and press the **Black Button**. Select either the "-" or "+" *Icons*. Start with the "+" *Icon* to start the manual Lamp Test from Column 1, Row 1, Switch 1. Press the **Black Button** on the "+" *Icon*, as each lamp is selected, the lamp will light at it's location on the playfield as well as the display, indicating the Lamp Matrix Grid position, lamp name with the corresponding number, Return (Row) Wire & Color, Drive (Column) Wire & Color, and associated drive transistors. Press the **Black Button** again to move forward in the test. To test and view a particular lamp, select the "RUN" *Icon* and press the **Black Button**. Each time the **Black Button** is pushed, the lamp will light-up on the playfield, with the display indicating the lamp information. Continue with the same procedure to run through the entire test.

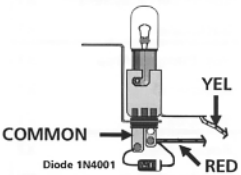
Test All Lamps

To initiate, from the **LAMP MENU**, select the "ALL" *Icon* with either **Red** or **Green Button** and press the **Black Button**. If still in Single Lamp Test (or any 1 of the 4 tests), select the "PREV" *Icon* to return to Lamp Menu or selecting either of the "ARROW" *Icons* will move through the tests, keep activating until Test All Lamps is displayed. The display will indicate "ALL LAMPS ON" and the lamps on the playfield will be lit, alternating between the rows in the Lamp Matrix.

Continued on the next page with Row & Column Lamp Tests.

Typical Lamp Schematic & Side View





LAMP MATRIX GRID

Row (GND) \ Column (18v)	1: U10 YEL-BRN J13-1	2: U11 YEL-RED J13-3	3: U12 YEL-ORG J13-4	4: U13 YEL-BLK J13-5	5: U14 YEL-GRN J13-6	6: U15 YEL-BLU J13-7	7: U16 YEL-VIO J13-8	8: U17 YEL-GRY J13-9
1: Q33 RED-BRN J12-1	GRID: Life Support #555 Bulb 1	GRID: Manual Burn #555 Bulb 2	GRID: CO_2 #555 Bulb 3	GRID: Master Alarm #555 Bulb 4	GRID: Rocket 2-Ball #555 Bulb 5	GRID: Docking #555 Bulb 6	GRID: Moon's Gravity #555 Bulb 7	GRID: Orbiter #555 Bulb 8
2: Q34 RED-BLK J12-2	SHOOT AGAIN #44 Bulb 9	SPECIAL (Right Outlane) #44 Bulb 10	LITE ORBIT (Rt Return) #44 Bulb 11	LITE ORBIT (Lt Return) #44 Bulb 12	SPECIAL (Left Outlane) #44 Bulb 13	NOT USED 14	GRID: Lite Extra Ball #555 Bulb 15	GRID: Under Volt #555 Bulb 16
3: Q35 RED-ORG J12-3	ORBIT PROGRESS #8 #555 Bulb 17	ORBIT PROGRESS #7 #555 Bulb 18	ORBIT PROGRESS #6 #44 Bulb 19	ORBIT PROGRESS #5 #44 Bulb 20	ORBIT PROGRESS #4 #44 Bulb 21	ORBIT PROGRESS #3 #44 Bulb 22	ORBIT PROGRESS #2 #44 Bulb 23	ORBIT PROGRESS #1 #44 Bulb 24
4: Q36 RED-YEL J12-4	VIDEO #44 Bulb 25	EXTRA BALL #44 Bulb 26	Right Eject Flame #44 Bulb 27	START MISSION (LEM) #44 Bulb 28	ORBIT PROGRESS #12 #44 Bulb 29	ORBIT PROGRESS #11 #44 Bulb 30	ORBIT PROGRESS #10 #44 Bulb 31	ORBIT PROGRESS #9 #44 Bulb 32
5: Q37 RED-GRN J12-5	MOON 4-Bank (Left) #555 Bulb 33	MOON 4-Bank (Mid-Lt) #555 Bulb 34	MOON 4-Bank (Mid-Rt) #555 Bulb 35	MOON 4-Bank (Right) #555 Bulb 36	(D)OCK #44 Bulb 37	D(O)CK #555 Bulb 38	DO(C)K #555 Bulb 39	DOC(K) #555 Bulb 40
6: Q38 RED-BLU J12-6	Left ORBIT #44 Bulb 41	FOOD #555 Bulb 42	Right Orbit Flame #44 Bulb 43	Right Ramp Flame #555 Bulb 44	Rocket Flame #555 Bulb 45	Spinner Flame #555 Bulb 46	Left Orbit Flame #44 Bulb 47	BATTERY #555 Bulb 48
7: Q39 RED-VIO J12-8	Moon Hurry-Up (Ramp) #555 Bulb 49	1-(3) Top Lane Right #44 Bulb 50	(1)-3 Top Lane Left #44 Bulb 51	A13 Spinner Lane #44 Bulb 52	Right ORBIT #555 Bulb 53	Right Turbo Bumper #555 Bulb 54	Bottom Turbo Bumper #555 Bulb 55	Left Turbo Bumper #555 Bulb 56
8: Q40 RED-GRY J12-9	START BUTTON #44 Bulb 57	NOT USED 58	NOT USED 59	WATER #555 Bulb 60	Up-Down Post #44 Bulb 61	MYSTERY #555 Bulb 62	13 BALL BLASTOFF #44 Bulb 63	BLASTOFF LETTER (Ramp) #555 Bulb 64
9: Q41 RED-WHT J12-10	(B)LASTOFF #44 Bulb 65	B(L)ASTOFF #44 Bulb 66	BL(A)STOFF #44 Bulb 67	BLA(S)TOFF #44 Bulb 68	BLAS(T)OFF #44 Bulb 69	BLAST(O)FF #44 Bulb 70	BLASTO(F)F #44 Bulb 71	BLASTOF(F) #44 Bulb 72
10: Q42 RED J12-11	NOT USED 73	NOT USED 74	NOT USED 75	NOT USED 76	NOT USED 77	NOT USED 78	NOT USED 79	NOT USED 80

Row and Column Lamp Tests

To initiate, from the **LAMP MENU**, select the "COL" *Icon* with either **Flipper Button** and press the **Black Button**. If still in a previous test, select the "PREV" *Icon* to return to Lamp Menu or selecting either of the "ARROW" *Icons* will move through the tests, keep activating until Row or Column Lamp Test (whichever desired) is displayed. In this test, each set of lamps in each row or column of the Lamp Matrix (respective to each test) will light-up on the playfield and is indicated in the display.

Lamp Matrix Location

The lamp locations correspond with the Lamp Number in the Lamp Maxtrix Grid on the previous page.

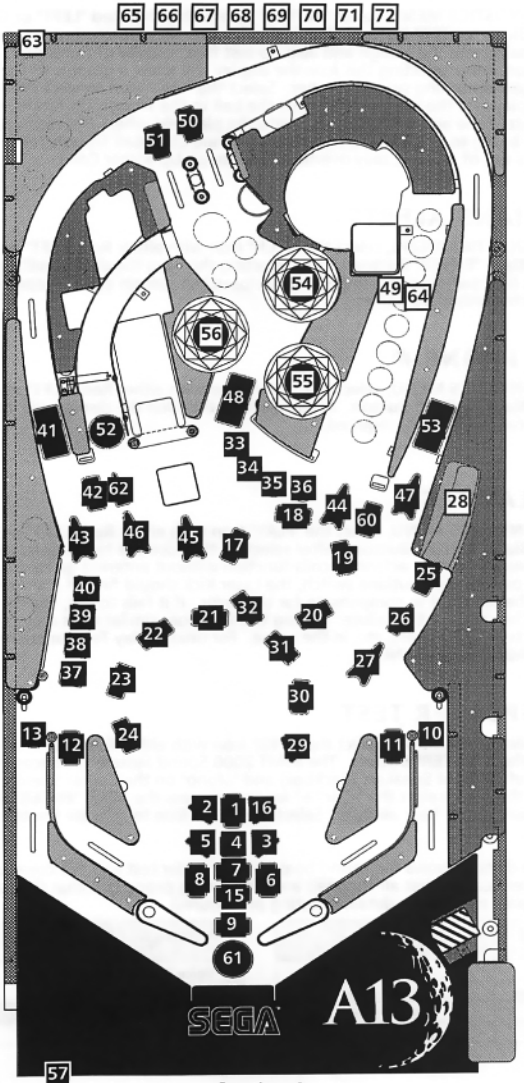
Legend Note:

□ = Lamps located above playfield.

■ = Lamps located below playfield.

The following Lamps are not used:

14 58 59 73
74 75 76 77
78 79 80



The following Bulb is used on the Lamp Boards, Turbo Bumpers, & Ramp Entrance Sign.

#555 Bulb (Wedge)
165-5002-00

The following Bulb is used in the remainder of the matrix:

#44 Bulb (Bayonet)
165-5000-44

TEST FLASH LAMPS

From the **DIAGNOSTICS MENU**, select the "FLASH" *Icon* with either **Red "LEFT"** or **Green "RIGHT" Button** and press the **Black "ENTER" Button**. After selecting this *Icon* the display will indicated "CYCLING FLASHERS" and all the flash lamps will cycle continuously until the test is exited. This test is allows the technician to easily spot any burned-out bulbs and replace them. Note: This test is also good to verify operation of the Left/Right Relay. If the relay does not function properly, coils may energize instead of the flash lamps.

CLEAR BALL TROUGH

From the **DIAGNOSTICS MENU**, select the "CLR" *Icon* with either **Red "LEFT"** or **Green "RIGHT" Button** and press the **Black "ENTER" Button**. This is provided to allow the technician a simple method of removing the balls from the trough and also, to test functionality of the trough, ensuring proper trough operation. After selecting this *Icon* the display will show a graphic of the ball trough with balls in the trough with it's corresponding switch number. Select the "RUN" *Icon* to eject the ball in the first position. Simultaneously, the display and the playfield will eject the ball to the Trough Up-Kicker, eject from the Trough Up-Kicker into the Shooter Lane and will be ejected onto the playfield where the technician can easily retrieve the pinball or allow the ball(s) to re-enter the trough to continue Clear Ball Trough Test.
(⚠ Caution: Continuous use of this test may overheat the Trough Up-Kicker Coil.)

TECHNICIANS ALERTS

From the **DIAGNOSTICS MENU**, select the "TECH" *Icon* with either **Red "LEFT"** or **Green "RIGHT" Button** and press the **Black "ENTER" Button**. After selecting this *Icon* the display will indicate if there are any faulty switches (i.e., switches that are normally closed but remain open or open switches that have not been closed (activated) in 50 games.)

SERVICE PHONE

From the **DIAGNOSTICS MENU**, select the "SERV" *Icon* with either **Red "LEFT"** or **Green "RIGHT" Button** and press the **Black "ENTER" Button**. After selecting this *Icon* the display will indicate a phone number to call if technical assistance is required.

BEGIN PLAY TEST

From the **DIAGNOSTICS MENU**, select the "PLAY" *Icon* with either **Red "LEFT"** or **Green "RIGHT" Button** and press the **Black "ENTER" Button**. After selecting this *Icon* the technician can test certain play functions to insure all switch activated coils function without entering game play. For example, by rolling the ball over the left outlane switch, the Laser Kick should fire. If it kicks to early or too late, the switch actuator should be adjusted to compensate for this error. If it fails to fire, use the Switch Test or Coil Test to help determine the cause of the failure. During this function, similar tests may be performed on the Vertical Up-Kickers, Ejects, Pop Bumpers, etc. in the game. For unique Play Test functions, select the "GAME SPECIFIC" *Icon* in the **DIAGNOSTICS MENU**.

SOUND/SPEAKER TEST

From the **DIAGNOSTICS MENU**, select the "SPKR" *Icon* with either **Red "LEFT"** or **Green "RIGHT" Button** and press the **Black "ENTER" Button**. The BSMT 2000 Sound System produces true digital stereo sound on the Left & Right Speakers (Backbox) and "*Mono*" on the Center Speaker (Bottom of Cabinet). After selecting this *Icon*, select the "-" or "+" *Icons* and press the **Black "ENTER" Button** to activate the first test. Repeat to visually see & hear all tests. Select the "RUN" *Icon* to activate the test chosen without moving to the next test.

During Sound Tests, the display shows the sound board circuit under test and the corresponding sounds. The sound functions allow verification that all channels are functioning properly & that the speaker connections are correct. (Refer to the game manual for detailed testing procedures).

Automatic / Manual Tests	Sounds Produced
Left Speaker	Left Sine
Both Left & Right Speakers	Center Sine
Right Speaker	Right Sine
Voice ROM 1 (Loc. U17)	Speech Pattern 1

Automatic / Manual Tests	Sounds Produced
Voice ROM 2 (Loc. U21)	Speech Pattern 2
Voice ROM 3 (Loc. U36)	Speech Pattern 3
Voice ROM 4 (Loc. U37)	Not Used
Sound/OPSYS EPROM (Loc. U7)	Level 1-3 (Music Test)

Speaker Phase Testing

Connections to each of the three speakers are polarized and each must be connected appropriately for the best quality sound. If one speaker has the positive and negative connections reversed with respect to the other two, bass frequencies will not be produced properly and the overall sound quality will be poor.

To test for proper speaker phasing, use the sound test to cycle through the Left, Center, and Right Sine functions. If the Center Sine produces more volume and bass than the Left and Right Sines, the speakers are connected properly. If it produces the same or less, one speaker is connected improperly. To isolate and correct reversed speaker connections, one of two methods may be used.

1. Check each speaker for polarity markings. If the speakers have polarity markings, verify that the single-color wire (BLK, YEL or RED) is connected to the negative (-) terminal.

2. Disconnect the speaker output connector from the CPU / Sound Board and connect a 1.5-volt battery across each speaker pair one at a time while observing the speakers. Make sure the positive battery terminal is connected to the positive lead (CN4- Pin 1, 3 or 6) each time. As the connection is made, check speaker cone movement; proper connections are indicated by outward movement.

BEGIN BURN IN

From the **DIAGNOSTICS MENU**, select the "BURN" *Icon* with either **Red "LEFT"** or **Green "RIGHT" Button** and press the **Black "ENTER" Button**. After selecting this *Icon* the Begin Burn-In Test will start. At this stage the game will exercise all CPU I/O Functions (Dot Matrix Display Test, Coil Testing, Lamp Testing, Sound, etc.). This is provided to constantly exercise sounds, coils, etc... Cumulative Burn-In minutes will be displayed. To reset Burn-In minutes to 00, select the "RESET" *Icon* in the **MAIN MENU** and select the "FACT" *Icon* (Factory Reset). See Chapter 5, Go To Reset Menu, of this section.

DOT MATRIX TEST

From the **DIAGNOSTICS MENU**, select the "DOT TEST" *Icon* with either **Red "LEFT"** or **Green "RIGHT" Button** and press the **Black "ENTER" Button**. After selecting this *Icon* the Dot Matrix Display Test immediately begins. The display will immediately illuminate and cycle for one pass of each test continuously for each of the following tests (Pressing any button will exit the test and return to **DIAGNOSTICS MENU**.):

1. Illuminates 1 vertical column of dots, turning it off & illuminating the next column, until each column has been individually lit, while the other columns are off.
2. Illuminates 1 horizontal row of dots, turning it off & illuminating the next row, until each row has been individually lit, while the other rows are off.
3. Illuminates all the dots, except for one column from left to right.
4. Illuminates all the dots except for one row from top to bottom.
5. Illuminates every other dot lit, in both the rows and columns.
6. Illuminates all dots at 30%, 70% & 100% brightness.

Dot Matrix Display Explained

The display utilizes a Micro-Processor Control Board mounted in piggyback fashion to the Dot Matrix Display Driver Board. The purpose behind this board is to provide more information (128 X 32 Dots) to the operator as well as displaying graphics to the player.

The board is controlled by a 68000 Microprocessor and its personality ROMs (Unique to the Game). It receives Data, Reset & Clock Information from the CPU Board via the ribbon cable and sends back multiple Status and Busy Signals to the CPU. This is to insure synchronized communication between the CPU and the Display Controller Board.

The Drivers for the rows and columns are provided on 5 surface mounted integrated circuits on the Dot Matrix Display Driver Board.

APOLLO SPECIFIC

From the **DIAGNOSTICS MENU**, select the "A13" *Icon* with either **Red "LEFT"** or **Green "RIGHT" Button** and press the **Black "ENTER" Button**. After selecting this *Icon* the technician can test and adjust any game specific function(s) from the sub-menu. Similar to "BEGIN PLAY TEST", this menu is used to test the game specific features. The features are the Rocket, Moon & 7-Segment LED Tests.

Rocket Test

To initiate, from the **APOLLO SPECIFIC MENU**, select the "RCKT" *Icon* with either the **Red** or **Green Button** and press the **Black Button**. In Rocket Test, press the **Start Button** to operate the Rocket. The motor on this mechanism is controlled by a Relay driven by Q20 on the I/O Power Driver Board. The display will also indicate the status of the two limit switches (Rocket Home (Down) & Rocket Up).

Moon Test

To initiate, from the **APOLLO SPECIFIC MENU**, select the "MECH" *Icon* with either the **Red** or **Green Button** and press the **Black Button**. In Moon Test, press the **Start Button** to operate the Moon. The motor on this mechanism is controlled by a Relay driven by Q19 on the I/O Power Driver Board. The display will also indicate the status of the two limit switches (Moon Home & Moon Forward).

7-Segment LED Test

To initiate, from the **APOLLO SPECIFIC MENU**, select the "LED" *Icon* with either the **Red** or **Green Button** and press the **Black Button**. In LED Test, press the **Start Button** to operate the LED. Each time the **Start Button** is depressed the next digit in the display will light up. Use this test to ensure all segments are working properly.

FLOW CHART MENU (DR. PINBALL)

To initiate, from the **DIAGNOSTICS MENU**, select the "DR." *Icon* with either the **Red "LEFT"** or **Green "RIGHT" Button** and press the **Black "ENTER" Button**. This will bring the operator/technician into the **FLOW CHART MENU** which offers the operator/technician a choice of four sub-menus: Flipper, Coil, Switch and Lamp. Selecting a particular sub-menu will give the operator/technician a choice of which specific lamp, switch or coil circuit needs to be diagnosed. In the **Flow Chart Menu**, the display will now request or give a procedure to follow such as "Does the lamp turn on?" or "Check bridge rectifier BR-20, if short replace". When Dr. Pinball asks a question or request a procedure the Dr. will expect a response such as "YES, NO, FIXED or NO PROBLEM" (see figure below) which you the operator/technician must input by using the **Green "SELECT" (RIGHT)** and/or **Black "ENTER" Buttons** on the coin door. The **Flipper Buttons** can be used to activate the particular circuit being diagnosed and in the **MAIN MENU** to select a menu item. The **Start Button** will allow the operator/technician to quit at anytime.

Your Notes

Your Notes

APOLLO 13
GAME AUDIT TABLE

Photocopy for Field Audit Tracking Performance (Use blank column to fill-in game audit totals)

EARNINGS AUDITS 1-12

Nº	Audit Name	Fill-In
1	TOTAL PAID CREDITS	
2	FREE GAME PERCENTAGE	
3	AVERAGE BALL TIME	
4	AVERAGE GAME TIME	
5	COINS THRU LEFT SLOT	
6	COINS THRU RIGHT SLOT	
7	COINS THRU CENTER SLOT	
8	COINS THRU 4TH SLOT	
9	TOTAL COINS	
10	TOTAL EARNINGS	
11	METER CLICKS	
12	SOFTWARE METER	

SEGA AUDITS 13-46

Nº	Audit Name	Fill-In
13	TOTAL BALLS PLAYED	
14	TOTAL EXTRA BALLS	
15	EXTRA BALL PERCENT	
16	REPLAY 1 AWARDS	
17	REPLAY 2+ AWARDS	
18	TOTAL REPLAYS	
19	REPLAY PERCENT	
20	TOTAL SPECIALS	
21	SPECIAL PERCENT	
22	TOTAL MATCHES	
23	HIGH SCORE AWARDS	
24	HIGH SCORE PERCENT	
25	TOTAL FREE PLAYS	
26	TOTAL PLAYS	
27	0.0M—99.9M SCORES	
28	100.0M—199.9M SCORES	
29	200.0M—399.9M SCORES	
30	400.0M—799.9M SCORES	

Continued

SEGA AUDITS 13-46

Nº	Audit Name	Fill-In
31	800.0M—1.19B SCORES	
32	1.2B+ SCORES	
33	AVERAGE SCORES	
34	SERVICE CREDITS	
35	PROPRIETARY	
36	PROPRIETARY	
37	PROPRIETARY	
38	TOTAL BUYIN GAMES	
39	EXTRA BALL BUYINS	
40	EXTRA BALL BUYIN REPLAYS	
41	E.B. BUYIN HSTDS	
42	LEFT DRAINS	
43	CENTER DRAINS	
44	RIGHT DRAINS	
45	SLAM TILTS	
46	TOTAL BALLS SAVED	

APOLLO 13 AUDITS 47-98

Nº	Audit Name	Fill-In
47	DOCK TARGETS COMPLETE	
48	LEFT ORBITS	
49	RIGHT ORBITS	
50	SPINNER SHOTS	
51	ROCKET SHOTS	
52	CENTER EJECT SHOTS	
53	RAMP SHOTS	
54	RIGHT EJECT SHOTS	
55	MOON TARGETS COMPLETE	
56	MYSTERY AWARDED	
57	BLASTOFF LETTERS	
58	BLASTOFF COMPLETE	
59	SKILL: START MISSION	
60	SKILL: MYSTERY	
61	SKILL: MBALL COUNT	

Continued

APOLLO 13 AUDITS 47-98

Nº	Audit Name	Fill-In
62	MULTIBALL READY	
63	13 BALL MBALL READY	
64	MULTIBALL STARTS	
65	MULTIBALL ABORTED	
66	2 BALL MULTIBALL	
67	3 BALL MULTIBALL	
68	4 BALL MULTIBALL	
69	13 BALL MULTIBALL	
70	MYSTERY 3 BALL MBALL	
71	MBALL RESTART LIT	
72	MBALL RESTART AWARDED	
73	JACKPOTS SCORED	
74	SUPER JACKPOTS SCORED	
75	LIFE SUPPORT STARTS	
76	MANUAL BURN STARTS	
77	CO2 STARTS	
78	ROCKET 2-BALL STARTS	
79	DOCKING STARTS	
80	MOON'S GRAVITY STARTS	
81	ORBITER STARTS	
82	X-BALL FROM GRID	
83	UNDER VOLT STARTS	
84	MASTER ALARM	
85	VIDEO LIT	
86	VIDEO AWARDED	
87	POWER DOWN STARTS	
88	POWER UP STARTS	
89	SPLASHDOWN STARTS	
90	TOTAL REGULAR PLAYS	
91	AVG. REGULAR GAME TIME	
92	REGULAR GAME MBALLS	
93	REGULAR GAME REPLAYS	
94	TOTAL NOVICE PLAYS	
95	AVG. NOVICE GAME TIME	
96	NOVICE GAME MBALLS	
97	NOVICE GAME REPLAYS	
98	AVG. NOVICE BALL SAVES	

Go To Audits Menu

Overview

The **Portals™ Service Menu System** provides 98 Audit Functions for accounting purposes and for evaluation of game difficulty adjustments. The Audit Functions are split into 3 groups. The first group, Earnings Audits, are the first 12 most-used audits. The second group, Sega Audits, are the game play generic audits (13-46). The last group, Apollo 13 Audits, are the game play specific audits (47-98). Each group may be viewed manually after entering the **Portals™ Service Menu** (see Chapter 1, Introduction, of this section). All audits can be viewed at a glance with the **Game Audit Table** provided on the previous page.

GO TO AUDITS MENU

With the game in the Attract Mode, open the Coin Door and press the **Black "BEGIN TEST" Button**. Select the "AUD" *Icon* in the **MAIN MENU** with either **Red "LEFT"** or **Green "RIGHT" Button** and press the **Black "ENTER" Button**. The **AUDITS MENU** appears.

Important Notes:

Exit any sub-menu and return to the **MAIN MENU** by selecting & activating the "PREV" *Icons*. If no *Icons* appear in the display because of a testing function or special display (e.g. "Help"), press any button to exit.

Selecting & activating the "QUIT" *Icon* from any display will exit the Service Session.

Selecting & activating the "HELP" *Icon* from any display will show a help screen. (An explanation of each *Mini-Icon* at that level will cycle continuously until any active button is pressed.)

Selecting & activating the "ARROW" *Icons* selects the next or previous audit in the group.

EARNINGS AUDITS (1-12)

From the **AUDITS MENU**, select the "EARN" *Icon* with either **Red "LEFT"** or **Green "RIGHT" Button** and press the **Black "ENTER" Button**. Select and activate the "RIGHT ARROW" *Icon* to view the 1st audit in this group. Continue to select either of the "ARROW" *Icons* to view each audit one at a time. The display will describe the audit number, the audit name, and the audit total or value. The current audit will remain in the display until the next audit is chosen or when the sub-menu is exited.

Au. Nº	Audit Name	Audit Definition
Au. 1	Total Paid Credits	Provides the total number of paid credits.
Au. 2	Free Game Percentage	This percentage is derived from dividing Audit 25, Total Free Plays, by Audit 26, Total Plays.
Au. 3	Average Ball Time	In seconds, the average ball time is derived from the total play time divided by Audit 13, Total Balls Played.
Au. 4	Average Game Time	The average game time is expressed in minutes and seconds.
Au. 5	Coins Thru Left Slot	Provides the total amount of coins registered through the left slot.
Au. 6	Coins Thru Right Slot	Provides the total amount of coins registered through the right slot.
Au. 7	Coins Thru Center Slot	Provides the total amount of coins registered through the center slot.
Au. 8	Coins Thru 4th Slot	Provides the total amount of coins registered through the fourth slot.
Au. 9	Total Coins	Provides the total amount of coins registered through all the slots.
Au. 10	Total Earnings	The total cash value accumulated since the last *Factory Restore* occurred (see Chapter 5, Go to Reset Menu, of this section).
Au. 11	Meter Clicks	Provides the total number of money clicks accumulated. (Based on the country's lowest coin denomination used for the game credit.)
Au. 12	Software Meter	Provides the continuing total of Meter Clicks. This audit cannot be reset; the display shows the constant addition of Meter Clicks.

SEGA AUDITS (13-46)

From the **AUDITS MENU**, select the "SEGA" *Icon* with either **Red "LEFT"** or **Green "RIGHT" Button** and press the **Black "ENTER" Button**. Select and activate the "RIGHT ARROW" *Icon* to view the 1st audit in this group. Continue to select either of the "ARROW" *Icons* to view each audit one at a time. The display will describe the audit number, the audit name, and the audit total or value. The current audit will remain in the display until the next audit is chosen or when the sub-menu is exited.

Au. Nº	Audit Name	Audit Definition
Au. 13	Total Balls Played	Provides the total of regular and extra balls.
Au. 14	Total Extra Balls	Provides the total number of extra balls awarded.
Au. 15	Extra Balls Percent	This percentage is derived from dividing Audit 14, Total Extra Balls, by Audit 26, Total Plays.
Au. 16	Replay 1 Awards	Provides the total awards (credit, extra ball, or audit) for level 1.
Au. 17	Replay 2+ Awards	Provides the total awards (credit, extra ball, or audit) for level(s) 2 or higher.
Au. 18	Total Replays	Provides the total awards (credits, extra balls, or audit only) for exceeding replay score levels.
Au. 19	Replay Percent	The replay total awards for exceeding replay score levels. This percentage is derived from dividing Audit 18, Total Replays, by Audit 26, Total Plays.
Au.20	Total Specials	Provides the total awards (credits, extra balls, or scores) for making specials.
Au. 21	Special Percent	This percentage is derived from dividing Audit 20, Total Specials, by Audit 26, Total Plays.
Au. 22	Total Matches	Provides the total credits awarded for matching the last two digits of the score with the system-generated Match Number at the end of the game. Percentage of match credits is adjustable from 0% to 10% by Ad. 11, Match Percentage, if enabled. (See Chapter 4, Go to Adjustments Menu, of this section.)
Au. 23	High Score Awards	Provides the total credits awarded for exceeding the High-Score-To-Date scores.
Au. 24	High Score Percent	This percentage is derived from dividing Audit 23, High Score Awards, by Audit 26, Total Plays.
Au. 25	Total Free Plays	Provides the total free credits for replays, High-Score-To-Date, Specials, and Match.
Au. 26	Total Plays	This total is derived by adding the sum of Audit 1, Total Paid Credits, and Audit 25, Total Free Plays. Note that free credits are not recorded in the Audit until they are actually used.
Au. 27	0.0M—99.9M Scores	Provides the total number of games the Player's final score was between 0 and 99,999,990 points.
Au. 28	100.0M—199.9M Scores	Provides the total number of games the Player's final score was between 100,000,000 and 199,999,990 points.
Au. 29	200.0M—399.9M Scores	Provides the total number of games the Player's final score was between 200,000,000 and 399,999,990 points.
Au. 30	400.0M—799.9M Scores	Provides the total number of games the Player's final score was between 400,000,000 and 799,999,990 points.
Au. 31	800.0M—1.19B Scores	Provides the total number of games the Player's final score was between 800,000,000 and 1,199,999,990 points.
Au. 32	1.2B+ Scores	Provides the total number of games the Player's final score was over 1,200,000,000 points.
Au. 33	Average Scores	This total is derived from adding the Final Score of each game to a table and dividing this sum by Audit 26, Total Plays.

Sega Audits Continued.

Audit Name	Audit Definition
Au. 34 **Service Credits**	Provides the total number of Service credits added to the game. (See Chapter 1, Introduction [*Access & Use*] for instructions on how to receive Service Credits.)
Au. 35, 36, 37 **Proprietary**	Provides information to the game designer to aid in design development (not for consumer use).
Au. 38 **Total Buyin Games**	Provides the number of times a player utilized the Buyin Feature. The Buyin Feature is adjustable using Ad. 34, Buyin Type. (See Chapter 4, Go to Adjustments Menu, of this section.)
Au. 39 **Extra Ball Buyins**	Provides the total number of times the Extra Ball Buyin Feature was used. The Extra Ball Buyin Feature is adjustable using Ad. 34, Buyin Type. (See Chapter 4, Go to Adjustments Menu, of this section.)
Au. 40 **E.B. Buyin Replays**	Provides the total number of replay awards that resulted from the use of Audit 39, Total Extra Ball Buyins.
Au. 41 **Extra Ball Buyin HSTDS**	Provides the total number of times in which use of the Extra Ball Buyin Feature resulted from beating the High-Score-To-Date (HSTD).
Au. 42 **Left Drains**	Provides the number of times the ball drained out the left drain.
Au. 43 **Center Drains**	Provides the number of times the ball drained out the center drain.
Au. 44 **Right Drains**	Provides the number of times the ball drained out the right drain.
Au. 45 **Slam Tilts**	Provides the number of times the Slam Tilt switch was activated.
Au. 46 **Total Balls Saved**	Provides the total number of times the Total Balls Saved Feature was used. This feature is enabled at the start of each ball and is disabled as soon as the ball makes contact with 5 game switches or allocated time expired.

APOLLO 13 AUDITS (47-98)

From the **AUDITS MENU**, select the "A13" *Icon* with either **Red "LEFT"** or **Green "RIGHT" Button** and press the **Black "ENTER" Button**. Select and activate the "RIGHT ARROW" *Icon* to view the 1st audit in this group. Continue to select either of the "ARROW" *Icons* to view each audit one at a time. The display will describe the audit number, the audit name, and the audit total or value. The current audit will remain in the display until the next audit is chosen or when the sub-menu is exited.

Au. №	Audit Name	Audit Definition
Au. 47	**Dock Targets Complete**	Provides the number of times the D-O-C-K Stand-Up Targets were completed.
Au. 48	**Left Orbits**	Provides the number of times a Left Orbit Shot was made.
Au. 49	**Right Orbits**	Provides the number of times a Right Orbit Shot was made.
Au. 50	**Spinner Shots**	Provides the number of times a Spinner Shot was made.
Au. 51	**Rocket Shots**	Provides the number of times a Rocket Shot was made.
Au. 52	**Center Eject Shots**	Provides the number of times a Center Ball Eject Shot was made.
Au. 53	**Ramp Shots**	Provides the number of times a Right Ramp Shot was made.
Au. 54	**Right Eject Shots**	Provides the number of times a Right Ball Eject Shot was made.
Au. 55	**Moon Targets Complete**	Provides the number of times all four Moon Targets were completed.
Au. 56	**Mystery Awarded**	Provides the number of times a Mystery Feature was awarded.
Au. 57	**BLASTOFF Letters**	Provides the number of times B-L-A-S-T-O-F-F Letters were collected.
Au. 58	**BLASTOFF Complete**	Provides the number of times the BLASTOFF Feature was completed.

Apollo 13 Audits Continued.

	Audit Name	Audit Definition
Au. 59	Skill: Start Mission	Provides the number of times the Skill Feature "Start Mission" was completed.
Au. 60	Skill: Mystery	Provides the number of times the Skill Feature "Mystery" was completed.
Au. 61	Skill: MBall Count	Provides the number of times the Skill Feature "MBALL Count" was completed.
Au. 62	Multiball Ready	Provides the number of times Regular Multiball was ready to be collected.
Au. 63	13 Ball Mball Ready	Provides the number of times 13 Ball Multiball was ready to be collected.
Au. 64	Multiball Starts	Provides the number of times Multiball was started.
Au. 65	Multiball Aborted	Provides the number of times Multiball was aborted by the player.
Au. 66	2 Ball Multiball	Provides the number of times 2 Ball Multiball was played.
Au. 67	3 Ball Multiball	Provides the number of times 3 Ball Multiball was played.
Au. 68	4 Ball Multiball	Provides the number of times 4 Ball Multiball was played.
Au. 69	13 Ball Multiball	Provides the number of times 13 Ball Multiball was played.
Au. 70	Mystery 3 Ball MBall	Provides the number of times "Mystery" 3 Ball Multiball was played.
Au. 71	Mball Restart Lit	Provides the number of times Multiball Restart was lit.
Au. 72	Mball Restart Awarded	Provides the number of times Multiball was restarted via a lit Multiball Restart.
Au. 73	Jackpots Scored	Provides the number of times Jackpots were collected.
Au. 74	Super Jackpots Scored	Provides the number of times Super Jackpots were collected.
Au. 75	Life Support Starts	Provides the number of times the feature "Life Support" was started.
Au. 76	Manual Burn Starts	Provides the number of times the feature "Manual Burn" was started.
Au. 77	Co_2 Starts	Provides the number of times the feature "CO_2" was started.
Au. 78	Rocket 2-Ball Starts	Provides the number of times the feature "Rocket 2-Ball" was started.
Au. 79	Docking Starts	Provides the number of times the feature "Docking" was started.
Au. 80	Moon's Gravity Starts	Provides the number of times the feature "Moon's Gravity" was started.
Au. 81	Orbiter Starts	Provides the number of times the feature "Orbiter" was started.
Au. 82	X-Ball From Grid	Provides the number of times X-Multiball was started from a Grid Feature.
Au. 83	Under Volt Starts	Provides the number of times the feature "Under Volt" was started.
Au. 84	Master Alarm	Provides the number of times the feature "Master Alarm" was started.
Au. 85	Video Lit	Provides the number of times the Video Light by the Right Eject was lit.
Au. 86	Video Awarded	Provides the number of times the Video Feature was collected.
Au. 87	Power Down Starts	Provides the number of times the feature "Power Down" was started.
Au. 88	Power Up Starts	Provides the number of times the feature "Power Up" was started.
Au. 89	Splashdown Starts	Provides the number of times the feature "Splashdown" was started.
Au. 90	Total Regular Plays	Provides the total Regular Games were played.
Au. 91	Avg. Regular Game Time	Provides the average game time of Regular played games.
Au. 92	Regular Game MBalls	Provides the number of times Multiballs were played in a Regular Game.

Apollo 13 Audits Continued.

	Audit Name	Audit Definition
Au. 93	**Regular Game Replays**	Provides the number of times replays were awarded in a Regular Game.
Au. 94	**Total Novice Plays**	Provides the total Novice Games were played.
Au. 95	**Avg. Novice Game Time**	Provides the average game time of Novice played games.
Au. 96	**Novice Game MBalls**	Provides the number of times Multiballs were played in a Novice Game.
Au. 97	**Novice Game Replays**	Provides the number of times replays were awarded in a Novice Game.
Au. 98	**Avg. Novice Ball Saves**	Provides the average number of times the Feature "Ball Save" (Freeze) was used to maintain the ball time criteria for a Novice Game.

Audit Note: 1st Way to Reset Audits

To reset audits, from the **MAIN MENU**, select the "ADJ" *Icon*. See Chapter 4, Go to Adjustments Menu, of this section.

Select the "SEGA" *Icon*, from the **ADJUSTMENT MENU**, and advance to Adj. 8, Reset Coin Audits, with the "RIGHT ARROW" *Icon*. Select the "+" *Icon* to change setting to **YES**. When enabled, the *Coin Audits* (5-11) will be reset to zero.

Advance to Adj. 9, Reset Game Audits, with the "RIGHT ARROW" *Icon*. Select the "+" *Icon* to change setting to **YES**. When enabled, *all the audits* will be reset to zero, except for the *Coin Audits* (5-11) and Audit 12, Software Meter (the only audit which cannot be reset to zero).

Audit Note: 2nd Way to Reset Audits

To reset audits, from the **MAIN MENU**, select the "RESET" *Icon*. See Chapter 5, Go to Reset Menu, of this section.

Selection of the "COIN" *Icon*, from the **RESET MENU**, will reset the *Coin Audits* (5-11) to zero.

Selection of the "AUD" *Icon*, from the **RESET MENU**, will reset all audits to zero, except for the *Coin Audits* (5-11) and Audit 12, Software Meter (the only audit which cannot be reset to zero).

APOLLO 13.
GAME ADJUSTMENT TABLE

Some adjustments have a "Drop-Down" Table where further customization is required.

SEGA ADJUSTMENTS 1-43

Nº	Adjustment Name	Factory Setting
1	REPLAYS: FIXED/MANUAL *"Drop-Down"*	10%
2	REPLAY LEVELS *"Drop-Down"*	1
3	REPLAY AWARD	CREDIT
4	FREE GAME LIMIT	5
5	EXTRA BALL LIMIT	3
6	GAME DIFFICULTY *"Drop-Down"*	MODERATE
7	GAME PRICING *"Drop-Down"*	USA7
8	RESET COIN AUDITS	NO
9	RESET GAME AUDITS	NO
10	RESET HIGH SCORES	NO
11	MATCH PERCENTAGE	9%
12	BALLS PER GAME	3
13	TILT WARNINGS	1
14	REPLAY BOOST	YES
15	CREDIT LIMIT	30
16	ALLOW HIGH SCORES	YES
17	HIGH SCORE #1 AWARDS	3
18	HIGH SCORE #2 AWARDS	1
19	HIGH SCORE #3 AWARDS	0
20	HIGH SCORE #4 AWARDS	0
21	DEFAULT HIGH SCORE #1	2,400,000
22	DEFAULT HIGH SCORE #2	2.100,000
23	DEFAULT HIGH SCORE #3	1,950,000
24	DEFAULT HIGH SCORE #4	1,800,000
25	DEFAULT HIGH SCORE #5	1,650,000
26	DEFAULT HIGH SCORE #6	1,500,000
27	HSTD RESET COUNT	2,000
28	FREE PLAY	NO
29	CUSTOM MESSAGE	ON
30	ATTRACT MODE MUSIC	ON
31	FLASH LAMP POWER	NORMAL

Continued

SEGA ADJUSTMENTS 1-43

Nº	Adjustment Name	Factory Setting
32	COIL PULSE POWER	NORMAL
33	MINIMUM GAME TIME	OFF
34	BUYIN TYPE	OFF
35	EXTRA BALL BUYIN COUNT	1
36	GAME RESTART	YES
37	EXTRA BALL PERCENTAGE	25%
38	BILL VALIDATOR	NO
39	TOURNAMENT MODE	NONE
40	EXT. REPLAY KNOCKER	OFF
41	SPECIAL MEMORY	YES
42	LOCATION ID	00
43	GAME ID	00

APOLLO 13 ADJUSTMENTS 44-54

Nº	Adjustment Name	Factory Setting
44	MBALL RESTART	MODERATE
45	EXTRA BALL MEMORY	ON
46	MULTIBALL CRITERION	MODERATE
47	ORBIT RULE CRITERION	MODERATE
48	MODE START CRITERION	MODERATE
49	"BLASTOFF" CRITERION	MODERATE
50	SHAKER MOTOR ENABLED	YES
51	MOON ENABLED	YES
52	ROCKET ENABLED	YES
53	8-BALL LOCK ENABLED	YES
54	NOVICE MODE ENABLED	YES

Go To Adjustments Menu

Overview

The **Portals™ Service Menu System** provides 54 Adjustment Functions to vary game difficulty or customize (i.e. adjusting High Score Levels, the number of balls per game, Extra Ball Buyin, Game Pricing, Default High Scores, etc.). The Adjustment Functions are split into 2 groups. The first group, Sega Adjustments, are the game play generic adjustments (1-43). The second group, Apollo 13 Adjustments, are the game play specific adjustments (44-54). Each group may be viewed manually after entering the **Portals™ Service Menu** (see Chapter 1, Introduction, of this section). All adjustments can be viewed at a glance with the **Game Adjustment Table** provided on the previous page. If a value is changed, the display will indicate **REQUEST INSTALLED**.

GO TO ADJUSTMENTS MENU

With the game in the Attract Mode, open the Coin Door and press the **Black "BEGIN TEST" Button**. Select the "ADJ" *Icon* in the **MAIN MENU** with either **Red "LEFT"** or **Green "RIGHT" Button** and press the **Black "ENTER" Button**. The **ADJUSTMENTS MENU** appears.

Important Notes:

Exit any sub-menu and return to the **MAIN MENU** by selecting & activating the "PREV" *Icons*. If no *Icons* appear in the display because of a testing function or special display (e.g. "Help"), press any button to exit.

Selecting & activating the "HELP" *Icon* from any display will show a help screen. (An explanation of each *Mini-Icon* at that level will cycle continuously until any active button is pressed.)

Selecting & activating the "QUIT" *Icon* from any display will exit the Service Session.

In Adjustments, selecting & activating the "-" *Icon* decrements the value setting. Selecting & activating the "+" *Icon* increments the value setting.

Selecting & activating the "ARROW" *Icons* selects the next or previous adj. in the group.

SEGA ADJUSTMENTS (1-43)

From the **ADJUSTMENTS MENU**, select the "SEGA" *Icon* with either **Red "LEFT"** or **Green "RIGHT" Button** and press the **Black "ENTER" Button**. Select and activate the "RIGHT ARROW" *Icon* to view the 1st adjustment in this group. Continue to select either of the "ARROW" *Icons* to view each adjustment one at a time. Select either the "-" or "+" *Icons* to change the value, if desired. The display will describe the adjustment number, the adjustment name, and the adjustment total or value. The current adjustment will remain in the display until the next adjustment is chosen or when the sub-menu is exited.

Adj. Nº	Adjustment Name	Adjustment Definition
Adj. 1	Replays: Fixed / Manual	Adjust for percentage of awards for Replay Levels (1% through 50%). Lower the automatic value to 0% and the display will indicated Fixed. Replays may be adjusted either for fixed levels or for a system-adjusted manual percentage of replay awards. Four levels may be selected. Adjustments allow awarding of a credit or an extra ball as each level is exceeded. With the manual percentage feature, if the actual replay percentage is higher or lower than that desired, the game computes new recommended manual percentage score(s). When the coin door is subsequently opened the player displays indicate the recommended level and a sound is made to alert the operator of a potential change. This new level is entered into adjustments simply by pressing the **Black "ENTER" Button**. (If the coin door is closed or the operator enters the Portals™ Service Menu, the replay level is not changed.)
Adj. 2	Relplay Levels	Adjust the number of replay levels to be active (1 to 4). Once the number of Replay Levels has been selected, a "Drop-Down" Table appears showing Replay Level 1. Adjust Replay Level 1 between 100M - 9.99B. Adjust Replay Level 2, 3 and/or 4 respectively.

Adjustment Name		Adjustment Definition
Adj. 3	Replay Award	Set for replays to award: **CREDIT, EXTRA BALL, NONE** or **SPECIAL** (When score threshold is achieved, a Playfield Special is lit.)
Adj. 4	Free Game Limit	Adjust the max. # of free games that may be accumulated per game; **0 - 9.**
Adj. 5	Extra Ball Limit	Adjust the max. # of extra balls that may be accumulated per game; **1 - 9** or **OFF.**
Adj. 6	Game Difficulty	Set to **EXTRA EASY, EASY, MODERATE, HARD** or **EXTRA HARD.** *(Note: Additional game features which are not adjusted may also change when adjusting this adjustment; see below table.)* Default is **MODERATE.** Any one of the ***INSTALL*** settings (in a "Drop-Down" Table) for this adjustment may be activated to automatically select settings for multiple adjustments affecting game difficulty. Select and activate the "-" or "+" *Icons* to choose the difficulty level required. After activation, the individual adjustments may be readjusted, if desired. Refer to the **Install Adjustment Table** below for details.

Adjustments which change when set to:	Adj. 6 Extra Easy	Adj. 6 Easy	Adj. 6 Moderate	Adj. 6 Hard	Adj. 6 Extra Hard
(44) MBall Restart	EXTRA EASY	EASY	EASY	HARD	EXTRA HARD
(45) Extra Ball Memory	ON	ON	ON	ON	OFF
(46) Multiball Criterion	EXTRA EASY	EASY	EASY	HARD	EXTRA HARD
(47) Orbit Rule Criterion	EXTRA EASY	EASY	EASY	HARD	EXTRA HARD
(48) Mode Start Criterion	EXTRA EASY	EASY	EASY	HARD	EXTRA HARD
(49) "BLASTOFF" Criterion	EXTRA EASY	EASY	EASY	HARD	EXTRA HARD

Play Rules: Novelty & 5-Ball, plus Add-A-Ball Settings

The following three combinations are recommended for situations where local laws restrict certain game features regarding the use of replays or the number of balls per game:

Novelty Play Rules - Set to establish recommended settings for no free play or extra balls:

Adj.	*Adjustment* Name	*Setting*	*Adj.*	*Adjustment Name*	*Setting*
1	Replays: Fixed/Manual	Fixed	5	Extra Ball Limit	00
2	Replay Levels	None	11	Match Percentage	Off
3	Replay Award	None	17	High Score #1 Awards	3
4	Free Game Limit	00	18	High Score #2 Awards	1

5-Ball Play Rules - Set to establish recommended settings for 5-ball play:

Adj.	Adjustment Name	*Setting*	*Adj.*	Adjustment Name	*Setting*
1	Replays: Fixed/Manual	07%	5	Extra Ball Limit	3
2	Replay Levels	1	11	Match Percentage	4
3	Replay Award	Credit	12	Balls Per Game	5
4	Free Game Limit	5	17	High Score #1 Awards	3
			18	High Score #2 Awards	1

Add-A-Ball Settings-To disable awarding of credits and provide awards with an extra ball:

Adj.	*Adjustment Name*	*Setting*	*Adj.*	*Adjustment Name*	*Setting*
3	Replay Award	Extra Ball	16	Allow High Scores	No
4	Free Game Limit	00	17-20	High Score #1 - #4 Awards	00
11	Match Percentage	Off			

Adjustment Name	Adjustment Definition
Adj. 7 Game Pricing	There are two methods available for coin switch programming: Standard & Custom. Standard pricing uses a single adjustment as seen in the first display. See the Standard Pricing Table. If "Custom" is selected, a "Drop-Down" Table appears. Select a pricing scheme shown in the **Custom Pricing Table** as seen below.

With Adjustment 7 set to **CUSTOM** operating the Enter Button again initiates a drop down menu representing coin switch pulses for the left, right, center and fourth coin slots. The prescribed the number of pulses are required for one credit. For example, if *Left Coin Pulses,* was set to 02 and *Coin Switch Pulses Required for 1 Credit*, to 01 a coin in the left slot would produce two credits. Further, if *Left Coin Pulses,* was set to 01 and *Coin Switch Pulses Required for 1 Credit*, to 02, two coins in the left slot would be required for one credit.

Coin Switch Pulses Required for Bonus Credit may be set to post bonus credits when a minimum amount of coins are inserted at one time. For example, if *Left Coin Pulses* was set to 01, *Coin Switch Pulses Required for 1 Credit* to 01 and *Coin Switch Pulses Required for Bonus Credit* to 04, one credit would be posted for each of the first three coins in the left slot and two credits for the fourth coin.

Standard/Custom Pricing - Set for the desired pricing scheme from the Standard Pricing Table as indicated on the dot matrix display. For Custom Pricing, set to **CUSTOM**. When set to **CUSTOM**, the following adjustments are utilized to tailor each individual coin chute.

Left Coin Switch Pulses - Set the number of pulses registered for closure of the left coin switch; **00** to **99**.

Right Coin Switch Pulses - Set the number of pulses registered for closure of the right coin switch; **00** to **99**.

Center Coin Switch Pulses - Set the number of pulses registered for closure of the center coin switch; **00** to **99**.

4th Coin Switch Pulses - Set the number of pulses registered for closure of the fourth coin switch; **00** to **99**.

Coin Switch Pulses Required for 1 Credit - Set the number of coin switch pulses required to post one credit; **00** to **99**.

Coin Switch Pulses Required for Bonus Credit - Set the number of coin switch pulses required to award the 1st bonus credit(s); **00** to **99**.

Coin Switch Pulses Required for 2nd Bonus Credit - Set the number of coin switch pulses required to award the 2nd bonus credit; **00** to **99**.

Credits awarded for 1st Bonus - Set the number of credits awarded for achieving the first Bonus level; **00** to **99**.

Custom Pricing Table

Coin Mechs					Adjustments							
Left	Right	Center	4th	*Plays/Coins*	Left Pulses	Right Pulses	Mid Pulses	4th Pulses	Pulses /Credit	Pulses /Bonus	Pulses /2nd Bonus	Credit /1st Bonus
25¢	25¢	$1.00	N/U	1/25¢ 3/50¢ 1/25¢ 5/$1.00 1/25¢ 6/$1.00	01 01 05	01 01 05	04 04 20	00 00 00	01 01 04	02 04 20	00 00 00	01 01 01
5*SCH*	10*SCH*	10*SCH*	N/U	1/10 S 1/10 S 4/30 S	01 04	02 08	02 08	00 00	02 06	00 00	00 00	00 00
10*p*	£1	50*p*	20*p*	1/30*p* 2/50*p* 5/£1 1/50*p* 3/£1 1/30*p* 4/£1	01 01 01	15 15 12	06 05 05	02 02 02	03 05 03	00 00 00	00 00 00	00 00 00
20¢	$1.00	N/U	N/U	1/60¢ 2/$1.00	01	05	00	00	03	05	00	01

Standard Pricing Table

on the next page.

Standard Pricing Table

Adj. 7 Standard Pricing Select	Coin Mechanisms: Left 1st Slot	Center 2nd Slot	Right 3rd Slot	Right 4th Slot	Pricing Scheme Explained (Number of "Plays" for Price Amount Shown)			
USA 1	25¢	$1	25¢		1/25¢			
USA 2	25¢	$1	25¢		1/50¢	2/75¢	3/$1	
USA 3	25¢	$1	25¢		1/50¢			
USA 4	25¢		25¢		1/50¢			
USA 5	25¢	$1	25¢		1/50¢	5/$2		
USA 6	25¢	$1	25¢		1/50¢	2/'4X25¢'	3/$1(bill) ← Used to promote the Bill Validator	
USA 7 ★	25¢	$1	25¢		1/50¢	4/$1.50	6/$2	
Austria	5S	10S	10S		1/10S	2/15S	3/20S	
Australia	20¢	$A 1	$A 2		1/$A 1	2/$A 2		
Australia 2	20¢	$A 1	$A 2		1/$A 1	2/$A 2		
Belgium	5 BF	20 BF	50 BF		1/20 BF	3/50 BF		
Canada	25¢	25¢	Can$ 1		1/50¢	2/75¢	3/Can$ 1	
Denmark 1	1DKr	5 DKr	10 DKr	20 DKr	1/3 DKr	2/5 DKr		
Denmark 2	1DKr	5 DKr	10 DKr	20 DKr	1/2 DKr	3/5 DKr	7/10 DKr	
Finland	1Fmk	5Fmk			1/5Fmk	4/10Fmk		
France 1 ★	1 Fr	5 Fr	10 Fr	20 Fr	1/3 Fr	2/5 Fr	5/10 Fr	11/20 Fr
France 2	1 Fr	5 Fr	10 Fr	20 Fr	1/5 Fr	3/10 Fr	7/20 Fr	
France 3	1 Fr	5 Fr	10 Fr	20 Fr	1/3 Fr	2/5 Fr	4/10 Fr	9/20 Fr
Germany 1	1DM	2DM	5DM		1/1 DM	5/5DM		
Germany 2	1DM	2DM	5DM		1/1DM	6/5DM		
Germany 3 ★	1DM	2DM	5DM		1/2DM	2/3DM	3/4DM6	6/6DM
Greece	50Dr		100Dr		1/50Dr	3/100Dr		
Holland (See Netherlands)								
Hungary	10 Ft	10 Ft	20 Ft		1/20 Ft	3/40 Ft		
Italy 1	500 Lit		500 Lit		1/500 Lit			
Italy 2	500 Lit		500 Lit		1/1000 Lit	3/2000 Lit		
Japan			100¥		1/100¥	3/200¥		
Korea	100Won		100Won		1/100Won			
Netherlands 1	1 Fls.	1 Fls.	2.5 Fls.		1/1Fls.	3/2.5 Fls.		
Netherlands 2 ★	1 Fls.	2.5 Fls.	5 Fls.		1/1Fls.	3/2.5 Fls.	6/5 Fls.	
New Zealand 1	$NZ 1		$NZ 2		1/$NZ 1	2/$NZ 2		
New Zealand 2	$NZ 1		$NZ 2		1/$NZ 1	3/$NZ 2		
Norway 1	10 NKr	5 NKr	20 NKr		2/10 NKr	1/5 NKr	4/20 NKr	
Norway 2	10 NKr	5 NKr	20 NKr		1/10 NKr	3/20 NKr		
Spain	100Pts		500Pts		1/100Pts	6/500Pts		
Sweden	1 SKr	5 SKr	10 SKr		1/10 SKr	2/15 SKr	3/20 SKr	
Switzerland 1 ★	1 SwF	2 SwF	5 SwF		1/1 SwF	6/5 SwF		
Switzerland 2	1 SwF	2 SwF	5 SwF		1/1 SwF	3/2 SwF	9/5 SwF	
UK 1	10p	50p	1£	20p	1/50p	3/1£		
UK 2	10p	50p	1£	20p	1/40p	3/1£		
UK 3 ★	10p	50p	1£	20p	1/50p			
Yugoslavia	5 Din		5 Din		1/5 Din			

★ ***Default Factory Setting***

Adjustment Name		Adjustment Definition
Adj. 8	Reset Coin Audits	Default is **NO**. Select the "+" *Icon* to change to **YES**. ⚠ When enabled, all *Coin Audits* (Audits 5-11), will be reset to zero.
Adj. 9	Reset Game Audits	Default is **NO**. Select the "+" *Icon* to change to **YES**. ⚠ When enabled, all audits will be reset to zero, except for the *Coin Audits* (Audits 5-11) and Audit 12, Software Meter (the only audit which cannot be reset to zero).
Adj. 10	Reset High Scores	When enabled (set to **YES**) the High Score Levels and associated initials will be restored to the backup settings when the "+" *Icon* is selected and activated.
Adj. 11	Match Percentage	Set Match percent from **00%** to **10%** or **OFF**. At **00%** the match display occurs at the end of the game but never awards a credit.
Adj. 12	Balls Per Game	Adjust the number of balls per game; **2** to **5**. Default is **3**.
Adj. 13	Tilt Warnings	Adjust the number of plumb bob tilt switch closures before the ball in play is tilted; **1**, **2**, **3** or **OFF**.
Adj. 14	Replay Boost	Set to **YES** or **NO**. When set to **YES**, exceeding a replay will set a temporary replay level for each time a replay level is surpassed. This new level will equal the previous replay level (when the replay was awarded) plus 50 Million for each following game, until the replays have all been played. At this time the previous level is resumed.
Adj. 15	Credit Limit	Adjust the maximum number of credits that may be posted; **4** to **50**. Default is **30**.

Note: There are 4 of the 6 High Score Levels with associated player initials that are displayed during the attract mode. This provides a High-Score-To-Date feature. When players exceed these levels, the player initials may be entered to replace the previous ones. These levels may be adjusted to award credits and to be reset to backup values after a selected number of games.

Adj. 16	Allow High Scores	Set to enable (set to **YES**) or disable the four high score levels by setting to zero.
Adj. 17	High Score #1 Awards	Adjust the number of awards (**0** to **4**) awarded for exceeding level 1 (the highest of the four levels).
Adj. 18	High Score #2 Awards	Adjust the number of awards (**0** to **3**) awarded for exceeding level 2.
Adj. 19	High Score #3 Awards	Adjust the number of awards (**0** to **2**) awarded for exceeding level 3.
Adj. 20	High Score #4 Awards	Adjust the number of awards (**0** to **1**) awarded for exceeding level 4.
Adj. 21-26	Default High Score #1 - #6	Adjust the score level to which the world record, (level 1) (the highest of the four levels) may be altered. This adjustment is not affected by Adj. 27, HSTD Reset Count. Adjust the backup score to which levels **2** - **6** may be reset, respectively.
Adj. 27	HSTD Reset Count	**HSTD** (**H**igh **S**core **T**o **D**ate). Adjust the number of games between automatic resets of high score levels to backup settings and ball time averager adjustments; **100** to **9,900** or **OFF** (no reset or adjustment). Default is **2,000**.
Adj. 28	Free Play	When set to **YES**, no coins are required for games.
Adj. 29	Custom Message	Set to **ON** or **OFF**. When set to **ON**, this function is used to establish a custom message periodically displayed during the attract mode. Set the feature to **CHANGE** selecting the "+" *Icon* The letter A is indicated in the first position in the display. Vary the letter by operating the left and right flippers. With the desired letter indicated, depress the **Start Button** to lock in the letter and advance to the next character. Repeat this procedure until the desired message is completed in the display.
Adj. 30	Atrract Mode Music	Set to **ON** or **OFF**. When set to **ON**, attraction music is played between games.

Adjustment Name		Adjustment Definition
Adj. 31	Flash Lamp Power	Set to **NORMAL**, **DIM** or **OFF**. When set to **NORMAL** the flash lamps are active, when **DIM** the flash lamps impulse power is reduced by **25%** and when **OFF** the flash lamps will not flash.
Adj. 32	Coil Pulse Power	Set to **NORMAL, HARD** or **SOFT**. When **HARD** the coil pulse power is ***increased*** by **12.5%** of the normal pulse rate. When set to **SOFT** the coil pulse power is ***decreased*** by **12.5%** of the normal pulse rate. These adjustments are provided to compensate for Low Line or High Line voltage conditions where the solenoids appear to kicking too weak or too hard. Adjust as required.
Adj. 33	Minimum Game Time	Default is **OFF**. Set between **0:01 - 8:59** for minimum game time. If the last ball in play drains prior to what the game time is set for, another ball will be served into the shooter lane and normal play will continue. Subsequent balls will continue to do be served into the shooter lane if the last ball still drains prior to and up until minimum game time is satisfied.
Adj. 34	Buyin Type	Set to **Extra Ball Buyin**. When set to **EXTRA BALL**, the game is set to Extra Ball Buyin. When set to **FEATURE**, the game is set to Game (Feature) Buyin. Set to **OFF** to make Buyin Type inoperative.
Adj. 35	Extra Ball Buyin Count	**1, 0** or **UNLIMITED**. Default is **1**. Allows the operator to adjust the number of Extra Ball Buyins allowed after normal game play. Review Section 2, Chapter 1, Game Operations & Features for details.
Adj. 36	Game Restart	Set to **YES** or **NO**. When set to **YES**, a new game may be started during any ball after the first ball is completed (if credits are available). (Note-Pressing start during the first ball will add additional players.) When set to **NO**, the game disables the **Start Button** after the first ball until the final ball is in play. Review Section 2, Chapter 1, Game Operations & Features for details.
Adj. 37	Extra Ball Percentage	Set from **0** to **50**. Allows the operator to adjust how frequently the Extra Ball feature is made available to the player.
Adj. 38	Bill Validator	Set to **YES** or **NO**. When set to **YES** , the display, in game attract mode, will show an "*Insert Bill Animation*". When set to **NO**, the display, in game attract mode will show "*Insert Coin Animation*".
Adj. 39	Tournament Mode	Set to **NONE, PINBALL EXPO, IFPA-PAPA** or **HOME**. Tournament Mode determines the default conditions to quickly prepare a game for tournament play. When this setting is changed all audits will be reset and all adjustments will be initiated to the particular style selected. The game will then return to game over attract mode, as if a Factory Reset had been performed. **NONE** - Same as a Factory Reset conditions. **IFPA**-Straight 50¢ play, no replay, no Extra Ball, no High Scores, 2 Tilt Warnings and No Match. **PINBALL EXPO-PAPA**-Same as **IFPA** settings except Free Play is enabled. **HOME**-Sets game for Free Play, extra ball play, no replay, **10%** Match & Extra Ball percent **30%**.
Adj. 40	Ext. Replay Knocker	Set to **ON** or **OFF**. When set to **ON**, the operator can enable the knocker in the cabinet to drive an external device without the game giving a replay.
Adj. 41	Special Memory	Set to **YES** or **NO**. When set to **YES**, the lit 'Special' light will be retained in memory from ball to ball for the same player. When set to **NO**, the lit 'Special' light will go out at the end of each ball.
Adj. 42	Location ID	**00** to **9999**. Allows the operator to assign a location identification number to the audit print-out sheet. (Will not be affected by Factory Reset.) See Chp. 5, Go to Reset Menu & Chp. 6, Go to Printer Menu, of this section for more details on Factory Reset & Printing.
Adj. 43	Game ID	**00** to **9999**. Allows the operator to assign a game identification number to the audit print-out sheet. (Will not be affected by Factory Reset.) See Chp. 5, Go to Reset Menu & Chp. 6, Go to Printer Menu, of this section for more details on Factory Reset & Printing.

APOLLO 13 ADJUSTMENTS (44-54)

From the **ADJUSTMENTS MENU**, select the "A13" *Icon* with either **Red "LEFT"** or **Green "RIGHT" Button** and press the **Black "ENTER" Button**. Select and activate the "RIGHT ARROW" *Icon* to view the 1st adjustment in this group. Continue to select either of the "ARROW" *Icons* to view each adjustment one at a time. Select either the "-" or "+" *Icons* to change the value, if desired. The display will describe the adjustment number, the adjustment name, and the adjustment total or value. The current adjustment will remain in the display until the next adjustment is chosen or when the sub-menu is exited.

Adj. Nº	Adjustment Name	Adjustment Definition
Adj. 44	MBall Restart	Set to **EXEASY, EASY, MODERATE, HARD** or **EXHARD**. Default is **EASY**. Determines how Multiball can restart.
Adj. 45	Extra Ball Memory	Set to **ON** or **OFF**. Default is **ON**. When set to **ON**, the lit 'Extra Ball' light will be retained in memory from ball to ball for the same player. When set to **OFF**, the lit 'Extra Ball' light will go out at the end of each ball.
Adj. 46	Multiball Criterion	Set to **EXEASY, EASY, MODERATE, HARD** or **EXHARD**. Default is **MODERATE**. Determines how Multiball is started.
Adj. 47	Orbit Rule Criterion	Set to **EXEASY, EASY, MODERATE, HARD** or **EXHARD**. Default is **MODERATE**. Determines how the Orbit Features are played.
Adj. 48	Mode Start Criterion	Set to **EXEASY, EASY, MODERATE, HARD** or **EXHARD**. Default is **MODERATE**. Determines how the different modes are played.
Adj. 49	"BLASTOFF" Criterion	Set to **EXEASY, EASY, MODERATE, HARD** or **EXHARD**. Default is **MODERATE**. Determines how the BLASTOFF features are played.
Adj. 50	Shaker Motor Enabled	Set to **YES** or **NO**. Default is **Yes**. When set to **YES**, the Shaker Motor will vibrate as required. When set to **NO**, it won't.
Adj. 51	Moon Enabled	Set to **YES** or **NO**. Default is **Yes**. When set to **YES**, the Moon & Magnet will operate as required. When set to **NO**, it won't.
Adj. 52	Rocket Enabled	Set to **YES** or **NO**. Default is **Yes**. When set to **YES**, the Rocket will operate as required. When set to **NO**, it won't.
Adj. 53	8-Ball Lock Enabled	Set to **YES** or **NO**. Default is **Yes**. When set to **YES**, the 8-Ball Lock Plunger will operate as required, allowing 13 Ball Play. When set to **NO**, it won't.
Adj. 54	Novice Mode Enabled	Set to **YES** or **NO**. Default is **Yes**. When set to **YES**, before game play, the player can choose Novice Play (a 1-Ball Game with a guaranteed play time). When set to **NO**, this feature is turned off, and defaults to Regular Game Play.

Custom Pricing

To go directly to Adjustment 7, Game Pricing, from the **ADJUSTMENT MENU**, select the "CUST" *Icon* either **Red "LEFT"** or **Green "RIGHT" Button** and press the **Black "ENTER" Button**. See details of this adjustment (Adj. 7) earlier in this chapter.

Film Star Reset

To reset the game with special settings (not the normal Factory Setting), from the **ADJUSTMENT MENU**, select the "STAR" *Icon* either **Red "LEFT"** or **Green "RIGHT" Button** and press the **Black "ENTER" Button**. This setting is determined to be ideal for the home environment. See Chapter 5, Go to Reset Menu, of this section, to change to factory defaults if changes made are not desired.

Adjustment Note: Resetting Adjustments

To reset adjustments, from the **MAIN MENU** select the "RESET" *Icon*. See Chapter 5, Go to Reset Menu, of this section.

Selection of the "FACT" *Icon*, from the **RESET MENU**, will reset all adjustments to the *Factory Settings* (except for Proprietary Adjustments). The display will return to the **Attract Mode**. To perform any other functions, the system must be entered again by pressing the **Black "BEGIN TEST" Button** on the coin door (see Chapter 1, Introduction, of this section).

Adjustment Note: Printing Game Information

To print audits, from the **MAIN MENU** select the "PRNT" *Icon*. See Chapter 6, Go to Printer Menu, of this section (special equipment required).

Selection of the "QUIK" *Icon*, from the **PRINTER MENU**, will start a quick print.

Selection of the "ALISON" *Icon*, from the **PRINTER MENU**, will start a Full Printout (Downloads to a PC).

Selection of the "RESET" *Icon*, from the **PRINTER MENU**, will reset the total Nº of copies value to zero.

Your Notes

Go To Reset Menu

Overview

The **Portals™ Service Menu System** provides three (3) functions to reset adjustments and/or audits back to the *Factory Setting*. See Chapter 3, Go to Audits Menu, and Chapter 4, Go to Adjustments Menu, for the Game Audits & Adjustments Information. If a Factory Reset is performed, the Service Session is exited and returns to the Attract Mode. If reset of Coin or Game Audits is performed, the display will indicate **REQUEST INSTALLED** and return to the **RESET MENU**. Please note that once reset, all customized settings are lost! Certain audits and adjustments however cannot be reset (refer to the details below).

GO TO RESET MENU

With the game in the Attract Mode, open the Coin Door and press the **Black "BEGIN TEST" Button**. Select the "RESET" *Icon* in the **MAIN MENU** with either **Red "LEFT"** or **Green "RIGHT" Button** and press the **Black "ENTER" Button**. The **RESET MENU** appears.

Important Notes:

Exit any sub-menu and return to the **MAIN MENU** by selecting & activating the "PREV" *Icon*.

Selecting & activating the "QUIT" *Icon* from the display will exit the Service Session.

Selecting & activating the "HELP" *Icon* from the display will show a help screen. (An explanation of each *Mini-Icon* at that level will cycle continuously until any active button is pressed.)

FACTORY RESET

From the **RESET MENU**, select the "FACT" *Icon* with either **Red** or **Green Button** and press the **Black Button**. ⚠ All adjustments will be reset to *Factory Settings* (except for Proprietary Adjustments). The display will indicate **REQUEST INSTALLED** and exit the Service Session. See Chapter 4, Go to Adjustments Menu, of this section, for the *Factory Settings* in the **Game Adjustment Table**.

RESET COIN AUDITS

From the **RESET MENU**, select the "COIN" *Icon* with either **Red** or **Green Button** and press the **Black Button**. ⚠ All Coin Audits (See **Fig. 1**) will be reset to Factory Settings. The display will indicate **REQUEST INSTALLED** and return to the **RESET MENU**. Coin Audits can also be reset from the **ADJUSTMENTS MENU, SEGA ADJUSTMENT 8**. See Chapter 4, Go to Adjustments Menu, of this section. After selecting this *Icon*, all of the ***Coin Audits (5-11)*** are reset to zero.

RESET GAME AUDITS

From the **RESET MENU**, select the "AUD" *Icon* with either **Red** or **Green Button** and press the **Black Button**. ⚠ All Game Audits (See **Fig. 2**) will be reset to Factory Settings. The display will indicate **REQUEST INSTALLED** and return to the **RESET MENU**. Game Audits can also be reset from the **ADJUSTMENTS MENU, SEGA ADJUSTMENT 9**. See Chapter 4, Go to Adjustments Menu, of this section. After selecting this *Icon*, all of the ***Audits*** are reset to zero, except for the Coin Audits (Audits 5-11) and Audit 12, Software Meter. Audit 12 is the only audit which cannot be reset.

Fig. 1

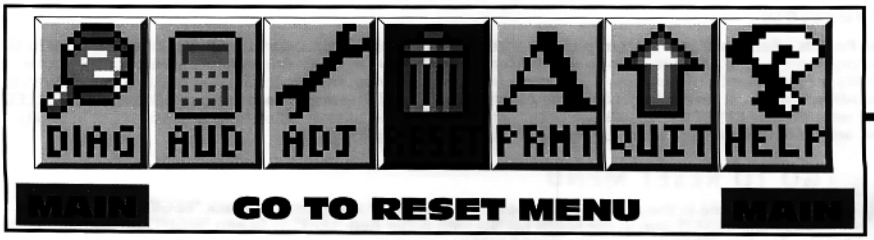
• Reset Coin Audits	
Earnings Audits (Coin Audits Only 5-11)	
Au. Nº	Description
1-4	The first 4 Audits in the game.
5	Coins Thru Left Slot
6	Coins Thru Right Slot
7	Coins Thru Center Slot
8	Coins Thru 4th Slot
9	Total Coins
10	Total Earnings
11	Meter Clicks
12	Software Meter
13 +	The remainder of the Audits.

Fig. 2

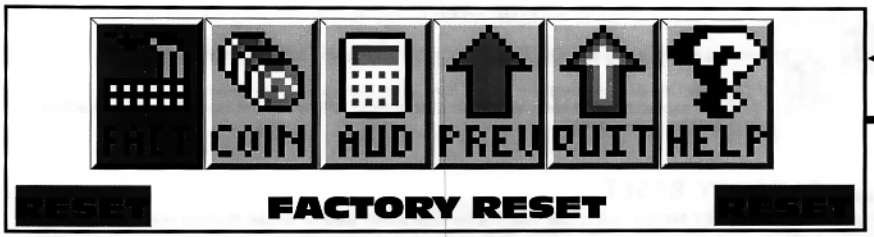
• Reset Game Audits	
Earnings (1-4), Generic/Specific Audits (13+)	
Au. Nº	Description
1-4	The first 4 Audits in the game.
5	Coins Thru Left Slot
6	Coins Thru Right Slot
7	Coins Thru Center Slot
8	Coins Thru 4th Slot
9	Total Coins
10	Total Earnings
11	Meter Clicks
12	Software Meter
13 +	The remainder of the Audits.

Example:

From the **MAIN MENU**, use the **Red** or **Green Buttons** to select the "RESET" *Icon* (GO TO RESET MENU).



Press the **Black Button** to activate this **ICON**. This will bring up the **RESET MENU**.



The **RESET MENU** now appears with the "FACT" *Icon* (FACTORY RESET) flashing:

CAUTION: IF CUSTOMIZED SETTINGS ARE MADE TO THE GAME, DO NOT PRESS THE START BUTTON OR THESE SETTINGS WILL BE LOST!

Press the **Black Button** to activate this icon. This will reset all adjustments back to *Factory Settings.*

The **REQUEST INSTALLED** now appears momentarily and the *Service Session* is automatically exited with the display returning to the **ATTRACT MODE**.

If the "COIN" or "AUD" *Icons* are chosen and activated, the affected audits (see previous page) will be reset, the display will indicate **REQUEST INSTALLED** and return to the **RESET MENU**.

Go To Printer Menu

Overview

☞ SPECIAL EQUIPMENT IS REQUIRED FOR THIS MENU

The **Portals™ Service Menu System** provides 3 Adjustment Functions to print information on a "Hand-Held" printer, download game information to a Laptop PC or clear the printout count. A printer interface board, hand-held printer and/or a special software program is required to run this menu. Entering this menu and selection/activation of the *Icons* without this equipment/software will not affect the game.

GO TO PRINTER MENU

With the game in the Attract Mode, open the Coin Door and press the **Black "BEGIN TEST" Button**. Select the "PRNT" *Icon* in the **MAIN MENU** with either **Red "LEFT"** or **Green "RIGHT" Button** and press the **Black "ENTER" Button**. The **PRINTER MENU** appears.

Important Notes:

Exit any sub-menu and return to the **MAIN MENU** by selecting & activating the "PREV" *Icons*. If no *Icons* appear in the display because of a testing function or special display (e.g. "Help"), press any button to exit.

Selecting & activating the "HELP" *Icon* from any display will show a help screen. (An explanation of each *Mini-Icon* at that level will cycle continuously until any active button is pressed.)

Selecting & activating the "QUIT" *Icon* from any display will exit the Service Session.

In printer adjustments, selecting & activating the "-" or "+" *Icons* is necessary to start a printout or download.

Selecting & activating the "ARROW" *Icons* selects the next /previous *Icon* in the sub-menu.

QUICK PRINTOUT ADJUSTMENT (55) (Printer Interface)

From the **PRINTER MENU**, select the "QUIK" *Icon* with either **Red** or **Green Button** and press the **Black Button**. Select the "+" *Icon* and press the **Black Button** to start the printout. Only the Earnings Audits can be printed out to a "Hand-Held" Printer.

FULL PRINTOUT ADJUSTMENT (56) (Alison Interface)

From the **PRINTER MENU**, select the "ALISON" *Icon* with either **Red** or **Green Button** and press the **Black Button**. Select the "+" *Icon* and press the **Black Button** to start the download. A special software program and a Lap Top PC is required. All game audits (Earnings, Sega & Game Specific) can be retrieved.

Nº OF COPIES PRINTED ADJUSTMENT (57)

From the **PRINTER MENU**, select the "RESET" *Icon* with either **Red** or **Green Button** and press the **Black Button**. Select the "+" *Icon* and press the **Black Button** to start the clear the "Nº of copies printed" count total.

PROBLEM/SOLUTION TABLE

Use this table for a quick simple solution(s) guide. For more technical assistance view Section 6.

PROBLEM	SOLUTION
Will not enter the Service Mode after depressing the **Black "BEGIN TEST" Button**.	• Check the Service Switch(es) for loose connections or bad Ground. • Check the assoicated wiring harness to/from the CPU Board Connector CN14. • Check CPU Board, possibly failed.
Service Buttons (**Green** and **Black**) are nonfunctional.	• Check the Service Switches for poor connections or broken wires.
The display blanks out.	• Check the Dot Matrix Display for loose wiring harness connections. • Check Bridge Rectifier 3 & 8 Amp Slo Blo Fuse. Refer to the Game Manual.
Icons "*scroll*" along continuously in the **MAIN MENU**.	• If the Service Switch Set and/or the Coin Door was replaced, ensure the Locking Mechanism on the **Green Button** is removed. If the Green Button "clicks" and locks into an up/down position, the Green Button has this lock switch. Remove it. (Ref. to Service Bulletin #74.)
The **Start** and **Flipper Buttons** do not select or activate *Icons* in the **SWITCH TEST MENU**.	• This is normal. These switches are deactivated, as they are a part of the Switch Test. Use the **Red "LEFT"** or **Green "RIGHT"** & **Black "ENTER" Buttons** in this Sub-Menu (See Chapter 1).
Some *Icons* appear non-functional in the **PRINTER MENU(S)**.	• If no printing equipment is connected, the "-" *Icon*, "+" *Icon* and "RUN" *Icon* will appear not to function (See Chapter 5).
Some *Icons* appear non-functional in the **GAME SPECIFIC MENU** under the **DIAGNOSTICS MENU**.	• If there is no other test under this Menu, the "Left Arrow" & "Right Arrow" *Icons* will appear not to function. The remaining *Icons* should function as normal. Note: If there is no Game Specific Special Test, the "GAME SPECIFIC" *Icon* will not invoke another display.
The display returns to the **ATTRACT MODE** exiting the Service Session from the **FACTORY RESET MENU**.	• This is normal. After a **FACTORY RESET**, the Service Session is automatically exited (See Chapter 4).
In **COIL TEST MENU**, the coils and flashlamps ***do not*** fire after activating the "RUN" *Icon*.	• Ensure the **POWER INTERLOCK SWITCH** (See figure on front inside cover) ***is pulled out***.
Can't move selection of *Icon* with the **Left** and/or **Right Flipper Buttons**.	• Check the **Flipper Buttons** for loose connections or bad Ground and refer to the Game Manual Flipper Troubleshooting Flowchart.
In **Portals™ Service Menu**, the volume cannot be adjusted with the Red or Green Buttons.	• The Volume adjustment can only be made when the Service Menu is exited. The **Volume Mode** is entered by pressing the **Red "VOLUME" Button**. Then use the **Red** or **Green Button** to increase/decrease volume. (Red "LEFT" decrements; Green "RIGHT" increments.)

Go To Help Screen

Overview

The **Portals™ Service Menu System** provides help screens in each display (except if the display is in a testing mode). Each screen is basic and some terms may vary. At the beginning of each chapter in this section, *Icons* are shown and described to give detail of the particular function of the individual *Icons*. The table on the previous page was designed to help answer some questions of situations which may arise.

GO TO HELP SCREEN

With the game in the Attract Mode, open the Coin Door and press the **Black "BEGIN TEST" Button**. Select the "HELP" *Icon* in the **MAIN MENU** with either **Red "LEFT"** or **Green "RIGHT" Button** and press the **Black "ENTER" Button**. The **HELP SCREEN** appears cycling through the different icon usages pertinent to that menu level.

MENU HELP SCREEN
USE THE RED OR GREEN BUTTONS TO CHANGE THE SELECTED ICON. PRESS THE BLACK BUTTON TO ACTIVATE THE SELECTED ICON. THE FLIPPER & START BUTTONS FUNCTION IN THE SAME WAY.

Important Notes:

Exit any sub-menu and return to the **MAIN MENU** by selecting & activating the "PREV" *Icons*. If no *Icons* appear in the display because of a testing function or special display (e.g. "Help"), press any button to exit.

Selecting & activating the "QUIT" *Icon* from any display will exit the Service Session.

Selecting & activating the "HELP" *Icon* from any display will show a help screen. (An explanation of each *Mini-Icon* at that level will cycle continuously until any active button is pressed.)

These "Mini-Icons" vary in functionality depending in what sub-menu they are used. Refer to the beginning of each chapter in this section for the function they serve in that menu or select the "HELP" *Icons* in the display where the *Icon* in question is being used.

Review Chapter 1, Introduction, on how to enter the **Portals™ Service Menu**. The chapter outlines the entire **Portals™ Service Menu**. View the **Icon Tree** in this manual which describes the names and menu descriptions of each *Icon*. View the display, after selecting and activating either of the "HELP" or "?" *Icons*.

Review Chapter 2, Go to Diagnostics Menu, to find all the tests needed to troubleshooting the game.

Review Chapter 3, Go to Audits Menu, and Chapter 4, Go to Adjustments Menu, to gather play information and to customize the game to vary difficulty of play or to change functions of the game.

Review Chapter 5, Go to Reset Menu, to reset audits and adjustments to Factory Settings.

Review Chapter 6, Go to Printer Menu, to start downloading or printing functions. Special equipment is required for this function.

This concludes the **Portals™ Service Menu**. Review the Table of Contents at the beginning of this manual, and the detailed Table of Contents for Section 3 to quickly find the information required. The remainder of the sections in this manual will cover all the parts in this game and provide helpful information to aide in trouble-shooting. If questions still arise after reading this section completely, call our Technical Support Department.

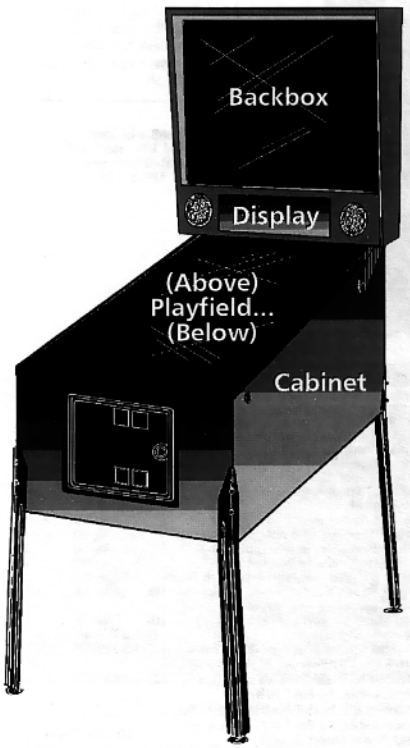
Your Help Notes:

Parts Identifcation & Location (The Pink Pages)

Overview

This section provides the part numbers and locations of the elements in the pinball game. The parts are arranged in basically four groups: Backbox, Cabinet, Atop Playfield, Below Playfield. (Some parts may be considered both aboue & below the playfield. The part will be grouped where it is predominant. Generic parts which may change as production continues (quantity and/or size) are listed together. The quantity indicates if that part is used in this game. Since quantity changes may occur, an item indicating "Ø" may be used. Compare the item which needs to be replaced with the drawings provided. The posts, sockets, bulbs and rubber rings are drawn actual size. Some parts which are complex (made up of numerous parts) will be noted in detail in Chapter 2, Assembly Drawings.

Section 4, Chapter 1
Table of Contents



Backbox
General Parts 54
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Above Playfield
Major Assemblies 56
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Butyrate, Decals & Mylar 59
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Below Playfield
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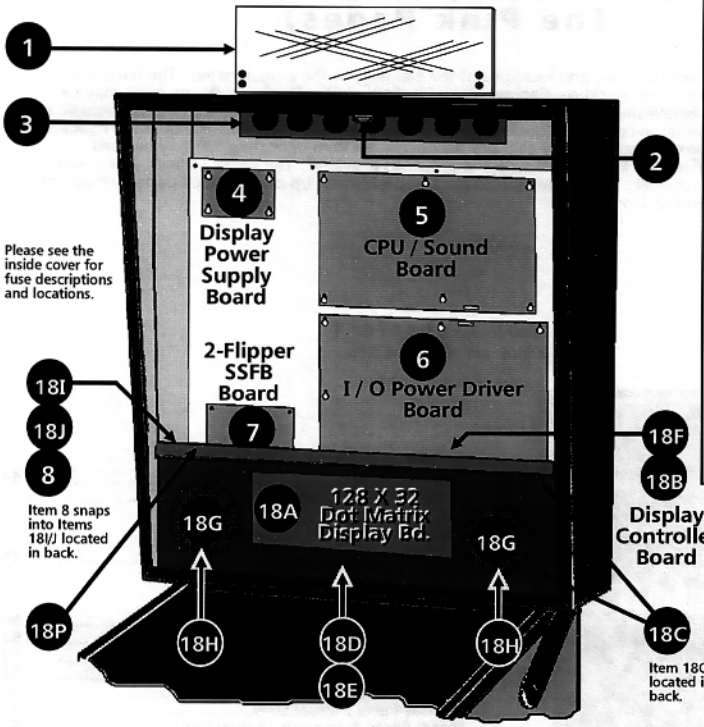
Backbox - General Parts



Please see the inside cover for fuse descriptions and locations.

Item 8 snaps into Items 18I/J located in back.

Item 18B is located behind 18A. Item 18F is located between Items 18B & 18A.

Item 18C is located in back.

Removal of...:

Insert (Item 9):
(Not Shown)
- Undo latch (Item 10) & swing completely open.
- Disconnect wire harness.
- Push up insert until female hinges (Item 12) are freed from male hinges (Item 11).
- Reverse procedure to reinstall.

Speaker Panel (Item 18):
- On the upper left of the panel, push down on the Push Button Release Assy.(Item 18I) releasing the Lock Pin (Item 8) & swing back.
- Disconnect wire harness.
- Lift out right side of panel/hinges (18C) from the backbox..
- Reverse procedure to reinstall.

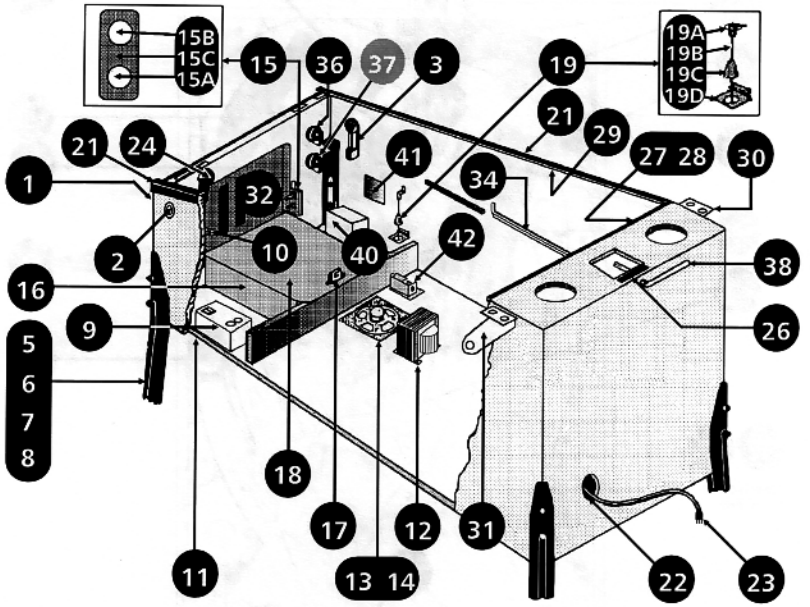
Nº	Part Name	SPI Part Nº
1	Apollo 13 Backbox Header	515-6468-19-44
2	Back Box Lock	355-5008-00
3	7-Vent Hole Grill 2½" x 18"	545-5072-02
4	Display Power Supply Board (New) †	520-5138-00
5	CPU / Sound (2 X 4MB) Board (New) †	520-5136-02
6	I / O Power Driver Board (New) †	520-5137-00
7	2-Flipper SSFB Board (New Location)	520-5080-00
8	Lock Pin / Lock Pin Bracket Assy. (New)	500-5916-01
ORDERING ABOVE (ITEM 8) ASSEMBLY PART Nº WILL INCLUDE:		
—	Lock Pin	530-5397-00
—	Lock Pin Bracket	535-7564-00
—	3/8" - 24 Jam Nut (Qty. 2)	240-5319-00
9 *	Apollo 13 Lights Insert Assembly *	505-6003-44-44
10 *	Lights Insert Slide Latch Special (New) *	535-7554-00
11 *	Lights Insert Hinge Male (Qty. 2) *	390-5014-01
12 *	Lights Insert Hinge Female (Qty. 2) *	390-5014-00
13 *	Backglass Clear 26½" x 19¾" *	660-5018-00
14 *	Apollo 13 Backglass Artwork *	830-5244-00
15 *	26-7/16" Plastic Extrusion *	545-5018-08
16 *	18-3/4" Plastic Extrusion * (Qty. 2)	545-5018-09
17 *	Glass Channel 26-7/16" *	545-5021-02

An asterisk (*) indicates items are not noted in the above pictorial.

Nº	Part Name	SPI Part Nº
18	Apollo 13 Speaker Panel Assembly	500-5995-00-44
ORDERING ABOVE (ITEM 18) ASSEMBLY PART Nº WILL INCLUDE:		
A	128 X 32 Dot Matrix Display Bd. ††	520-5052-00
B	Display Controller Board †	520-5055-01
C	Panel Hinge (Female) (Qty. 2)	390-5026-00
D	Speaker Panel (Hinged)	525-5365-03
E	Apollo 13 Speaker Plexi w/Artwork	830-5647-01
F	Static Shield	535-6437-00
G	Speakers 4X4 Quam 89-9572 (Qty. 2)	031-5004-00
H	Apollo 13 Speaker Grill w/Artwork (Qty. 2)	830-5648-00
I	Push Button Release Assembly (New)	515-6481-00
J	Push Button Release Bracket (New)	535-7582-00
K *	3/16" X 1/4" Self-Adhesive Foam 2.6 Feet	626-5026-00
L *	Ground Straps X.XX". (replace "-XX" with the inches required; e.g. 4" = "-04", etc.)	600-5006-XX
M *	3-Lug Stand-Up Long Socket (Qty. 8)	077-5009-00
N *	#44 Bulb (Qty. 8)	165-5000-44
O *	Sq. Light Covers. (See Color Chart at end of Sec. 4, Chp. 2 & replace the "-XX" w/the number.)	550-5019-XX
P	Top Channel Glass Retainer	545-5452-02
19 *	Ribbon Cable, 14-Pin * (Display Controller Bd. to Dot Matrix Display Bd.)	036-5260-00
20 *	Ribbon Cable, 20-Pin * (CPU/Sound Bd. to I/O Power Driver Board)	036-5000-04
21 *	Ribbon Cable, 26-Pin * (CPU/Sound Bd. to Display Controller Board)	036-5001-00
22 *	Fuse Description Decal	820-6152-44

† Note 1: When ordering PC Boards with ROMS, please specify the Game.
†† Note 2: Indicate Manufacturer.

Cabinet - General Parts

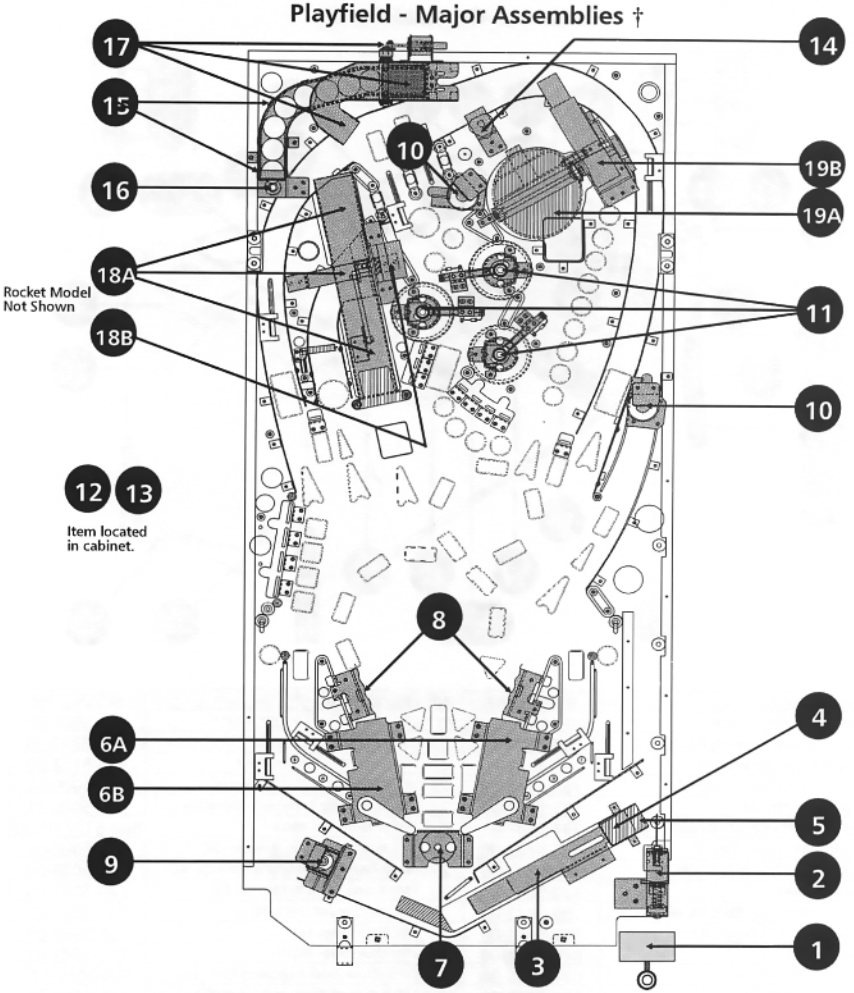


Nº	Part Name	SPI Part Nº
1	Ball Launch Assy. (See Sec. 4, Chp. 2)	500-6046-00-44
2	Flipper Button Assembly Red (Qty. 2)	500-5026-32
3	Flipper Power Switch, Left	180-5122-00
4 *	Flipper Power Switch, Right *	180-5122-00
5	Leg (Black) (Qty. 4)	535-5020-50
6	Leg Bolt 3/8"-16 x 2-1/2" Hex 5/8" Hd. (Qty. 8)	231-5001-01
7	Leg Bolt Back Plate (Qty. 4)	535-5703-00
8	Leg Leveler 3/8" - 16 X 3" (Qty. 4)	500-5017-00
9	Service Outlet	180-5008-01
10	Service Switch Set (RED, GRN, BLK Buttons)	180-5012-03
11	Power Sw. DPST Toggle (Under Cab.)	180-5001-00
12	Transformer	010-5011-00
13	Speaker - Round - 8" ø	031-5005-00
14	Speaker Grill 7" x 7"	535-6830-00
15	Dual Switch Assembly	500-5808-00
ORDERING ABOVE (ITEM 15) ASSEMBLY PART Nº WILL INCLUDE:		
15A	Memory Protect Switch	180-5000-00
15B	Interlock Switch	180-5136-00
15C	Bracket	535-6958-00
16	Cash Box Plastic Bottom	545-5090-00
17	Cash Box Lock Bracket (wire)	535-7562-00
18	Cash Box Cover (Validator)	535-5013-03
19	Plumb Bob Tilt Assembly	500-5023-00
ORDERING ABOVE (ITEM 19) ASSEMBLY PART Nº WILL INCLUDE:		
19A	Hanger Bracket (Tilt)	535-5221-00
19B	Hanger Wire (Tilt) (Attached to "19A")	535-5319-00
19C	Plumb Bob (Tilt) (Attached to "19B")	535-5029-00
19D	Contact Bracket (Tilt)	535-5220-00

Nº	Part Name	SPI Part Nº
20 *	Playfield Glass (T.P.) 21" x 43" *	660-5001-00
21	Side Armor - Left & Right	535-7297-00
22	Recessed Cup for Line Cord	545-5122-00
23	Line Cord 10' ROJ 3" Maximum	034-5000-10
24	Front Molding Lockdown Assembly	500-5020-01
25 *	Front Molding - Black *	500-5757-01-00
26	#1 Roto Lock Male, (Female -02) *	355-5006-01
27	Rear Plastic Ext. Playfield Glass 20-3/8"	545-5038-00
28	Mounting Foam Rubber for Ext.	626-5001-00
29	Plastic Channel Left & Right	545-5017-00
30	Backbox Hinge Left	515-5987-00
31	Backbox Hinge Right	515-5987-01
32	Coin Door (with Validator) USA only	500-5018-171
33 *	Slide & Pivot Support Bracket Right *	535-5989-00
34	Slide & Pivot Support Bracket Left	535-5990-00
35 *	Playfield Support Bar (Stay Arm) *	535-5019-00
36	Start Button Switch Assembly	500-5728-07
37	Extra Ball Buyin/League Button (Not Used)	500-5815-01
38	5/16" Hex Key Allen Wrench	777-0001-00
39 *	Switch / Lamp / Coil Matrix Information *	820-6104-44
40	Shaker Motor	515-5893-00
41	Shaker Motor P.C. Board	520-5065-00
42	Knocker Assy. (See Section 4, Chapter 2)	500-5081-00

An asterisk (*) indicates items are not noted in the above pictorial.

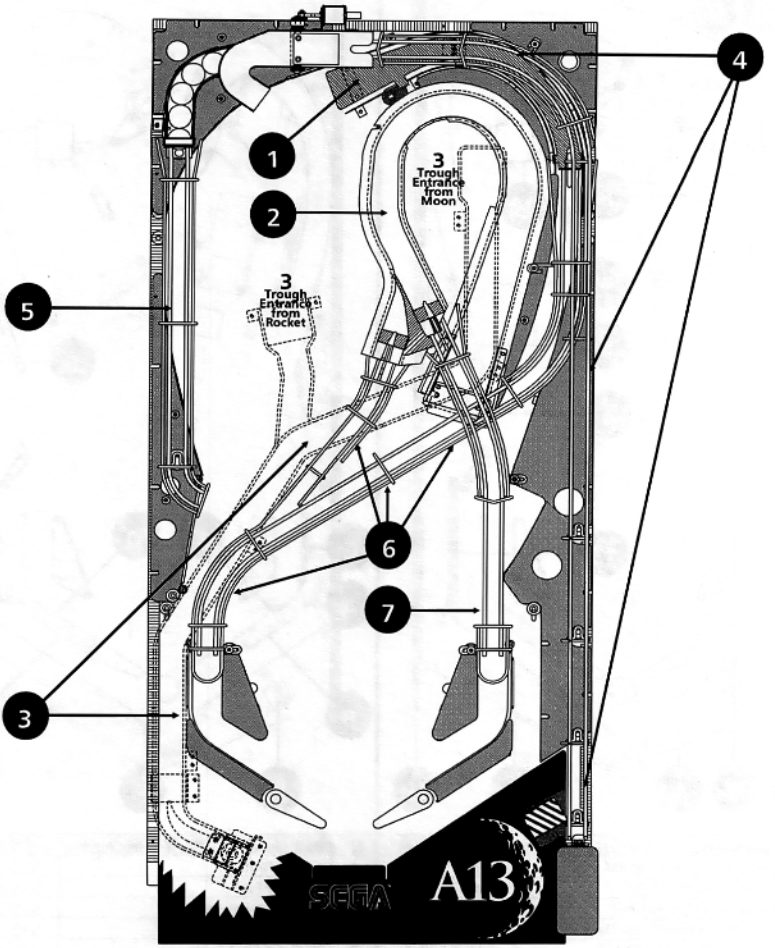
Playfield - Major Assemblies †



Nº	Assembly Name	PG.†	Part Nº	Nº	Assembly Name	PG.†	Part Nº
1 *	Abort Handle (Ball Launch) Assy. *	pg 70	500-6046-00-44	11	Turbo Bumper Assemblies (Qty. 3)	pg 75	See Sec. 4, Chp. 2
2	Auto Ball Launch Assembly	pg 70	500-5969-01-44	12 *	Shaker Motor *	pg 76	515-5893-00
3	5-Ball Trough Assembly	pg 71	500-5965-15-44	13 *	Knocker Assembly *	pg 76	500-5081-00
4	Lock Ball Assembly	pg 71	500-5684-01	14	Up-Down Ramp Plunger Assy.	pg 77	500-6044-00-44
5	Ball Trough Enter/Exit Scoop Assy.	pg 71	533-7329-01	15	8-Ball Lock Trough Assembly	pg 78	500-6025-00-44
6A	Flipper Assembly, Lower Right	pg 72	500-5944-02	16	8-Ball Lock Plunger Assembly	pg 78	500-5867-01-44
6B	Flipper Assembly, Lower Left	pg 72	500-5944-12	17	Upper Trough/Trap Door Assy.	pg 79	500-6031-00-44
7	Up-Down Bumper Post Assembly	pg 73	500-6023-00-44	18A	Rocket Ramp Assembly	pg 80	500-6020-00-44
8	Slingshot Assemblies (Qty. 2)	pg 73	500-5849-01	18B	Motor, Bracket & Cam Sup-Assy.	pg 81	515-6414-00
9	Super VUK Assy. (Under Arch)	pg 74	500-5880-00-44	19A	Moon Unit Assembly	pg 82	500-6021-00-44
10	Regular VUK Assys. (Qty. 2)	pg 74	500-5839-02-44	19B	Motor, Bracket & Cam Sub-Assy.	pg 83	515-6407-00

† See Section 4, Chapter 2, Assembly Drawings (with indicated page #) to identify the components of each assembly above.
An asterisk (*) indicates items are either in /on the cabinet.

Playfield - Ramps †

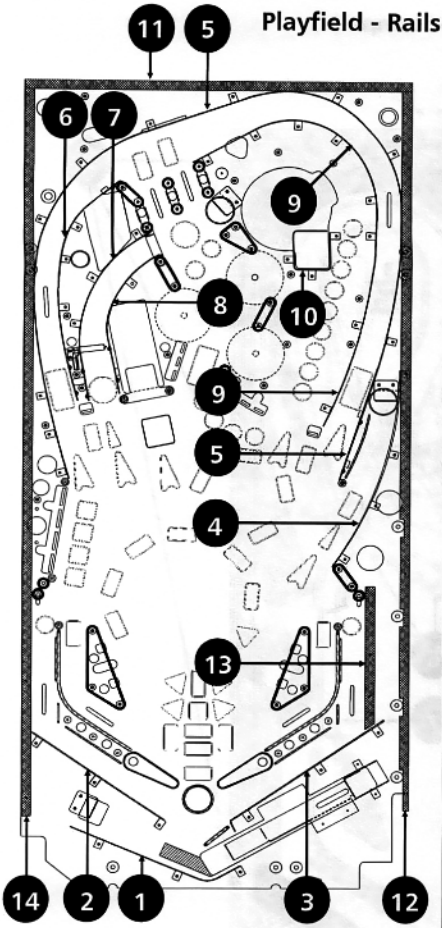


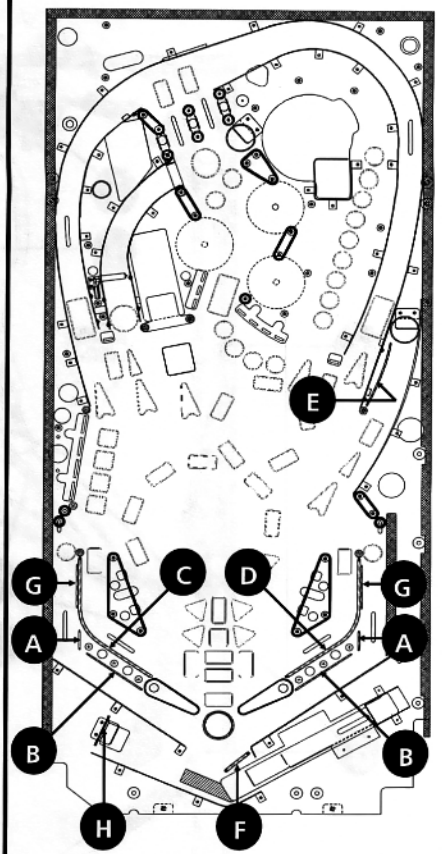
№	Plastic/Steel Ramp Name	PG.†	Part №
1	Up/Down Metal Ramp Assembly	pg 77	500-6042-00-44
2	Plastic Ramp Assembly	pg 84	500-6027-00-44
3	Plastic Under Trough Assembly	n/a	545-5637-00-44

† See Section 4, Chapter 2, Assembly Drawings, for breakdowns.

№	Wire Ramp Name	PG.†	Part №
4	Shooter Lane Wire Ramp	n/a	515-6419-00-44
5	8-Ball Trough Exit Wire Ramp	n/a	515-6388-00-44
6	Dual Exit to Lt. Return Wire Ramp	n/a	515-6460-00-44
7	Exit to Right Return Wire Ramp	n/a	515-6386-00-44

Playfield - Rails and Ball Guides

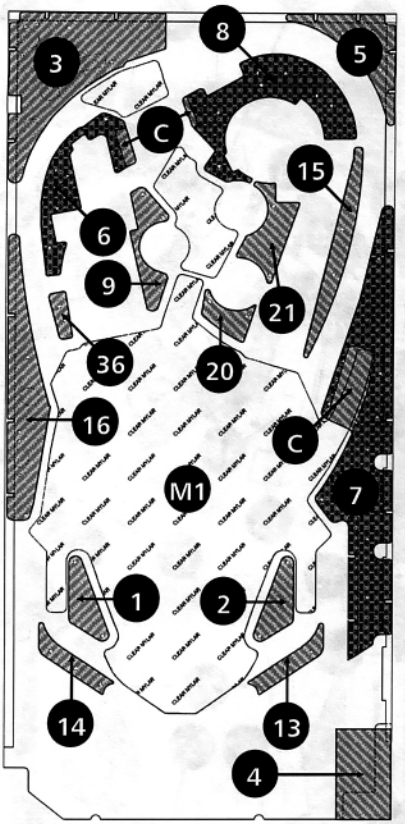




Nº	Rail Name	SPI Part Nº
1	Under Arch Center Flat Rail	535-7233-00
2	Under Arch Left Flat Rail	535-7238-01
3	Under Arch Right Flat Rail	535-7239-00
4	To Right Eject Right Side Flat Rail	535-7463-00
5	Large Outside Orbit Flat Rail	515-6389-00
6	Left Orbit Right Side Flat Rail	515-6396-00
7	Spinner Left Side Flat Rail	515-6397-00
8	Spinner Right Side Flat Rail	515-6398-00
9	Right Orbit Left Side Flat Rail	535-7460-00
10	Right Side Trough Entrance Flat Rail	535-7546-00
11	Wood Rail Top 20.25"	525-5007-05
12	Wood Rail Right Side	525-5401-00
13	Wood Rail (Short) Right Outlane	525-5402-00
14	Wood Rail Left Side 40.5"	525-5007-16

Nº	Ball Guides / Wire Forms Name	SPI Part Nº
A	1" Wire Form	535-5300-05
B	3.5" Wire Form	535-5300-03
C	Left Return Ball Guide	535-7560-00
D	Right Return Ball Guide	535-7560-01
E	Right Ball Eject Guide	535-5424-00
F	1.5" Wire Form	535-6492-13
G	Outlane Fence 2.38" Wire Form	535-7595-00
H	Fence 2" Wire Form	535-7670-00

Playfield - Butyrate, Decals and Mylar



Nº	Screened Butyrate Name	SPI Part Nº
	Butyrate Sheet Screened (1-40)	830-5484-XX
1	LEFT SLINGSHOT	830-5484-01
2	RIGHT SLING SHOT	830-5484-02
3	TOP LEFT CORNER (LOWER)	830-5484-03
4	AUTOLAUNCH COVER	830-5484-04
5	TOP RIGHT CORNER (LOWER)	830-5484-05
6	MIDDLE LEFT CORNER (LOWER)	830-5484-06
7	SHOOTER LANE (LOWER)	830-5484-07
8	UNDER PLASTIC RAMP	830-5484-08
9	LEFT POP (LOWER)	830-5484-09
10 *	SHOOTER LANE (UPPER) (Part of -07)	830-5484-10
11 *	CABINET BACK	830-5484-11
12 *	BACKPANEL	830-5484-13
13	RIGHT RETURN LANE (LOWER)	830-5484-13
14	LEFT RETURN LANE (LOWER)	830-5484-14
15	RIGHT PLASTIC RAMP	830-5484-15
16	MIDDLE LEFT SIDE (LOWER)	830-5484-16
17 *	RIGHT RAMP ENTER SIGN	830-5484-17
18 *	UPPER LEVEL (Part of -36)	830-5484-18
19 *	BACKBOX HEADER SIGN	830-5484-19
20	MIDDLE POP	830-5484-20
21	RIGHT POP (LOWER)	830-5484-21
22 *	BACKPANEL	830-5484-22
23 *	KEYCHAIN	830-5484-23
24 *	KEYCHAIN	830-5484-24
25 *	KEYCHAIN	830-5484-25
26 *	RT RETURN LANE (UPPER) (Part of -13)	830-5484-26
27 *	LT RETURN LANE (UPPER) (Part of -14)	830-5484-27
28 *	TOP RIGHT CORNER (UPPER) (Part of -05)	830-5484-28
29 *	MID LEFT CORNER (UPPER) (Part of -06)	830-5484-29
30 *	LEFT POP (UPPER) (Part of -09)	830-5484-30
31 *	MIDDLE LEFT SIDE (UPPER) (Part of -16)	830-5484-31
32 *	LEFT POP (UPPER) (Part of -21)	830-5484-32
33 *	TOP LEFT CORNER (UPPER) (Part of -03)	830-5484-33
34 *	TOP LEFT CORNER (UPPER) (Part of -03)	830-5484-34
35 *	SIGN (Part of -07)	830-5484-35
36	MIDDLE LEFT BOTTOM	830-5484-36
37 *	SIGN AROUND MOON (Part of -08)	830-5484-37
38 *	ROCKET LIGHTS (Under Rocket)	830-5484-38
40 *	RT PLASTIC RAMP (UPPER) (Part of -15)	830-5484-40

The following last 2-digits were not used on 830-5484-XX: -39

Nº	Decal Name	SPI Part Nº
D1 *	Complete Decal Sheel for Playfield	820-6136-XX

Some main decals are: -02, Install 5 Balls; -03, Install 13 Balls; -05, Trough Exit Scoop "Danger Exhaust"; -07, Flag; -08, USA; -09, Arch Left; -10, Arch Right; -11, Arch Center; -17, Pop Bumpers; -18, LEM; -19, "PRESS DOWN ON WHITE..."; -20, Portals™ Service Switch Set (Red, Green, and Black Buttons); -21, "TO REMOVE SPEAKER PANEL..."

Nº	Mylar Name	SPI Part Nº
M1	Mylar Sheet Complete (3 pieces)	820-5858-XX

Nº	Clear Butyrate Name	SPI Part Nº
C	Butyrate Sheet Clear (See note 3.)	830-5484-X1

1. An asterisk (*) indicates items are not noted in pictorial; see the note on where the piece(s) is located.
2. For entire butyrate sheet order part number with -XX.
3. Individual Clear Butyrate cannot be ordered. The entire sheet must be purchased if replacement is required. Order 830-5484-X1
4. To order individual replacement screened butyrate, replace the "-XX" with the correct 2-digit ending as noted in the table. (The last 2-digits of the part number is screened on each piece.)

Playfield - General Parts

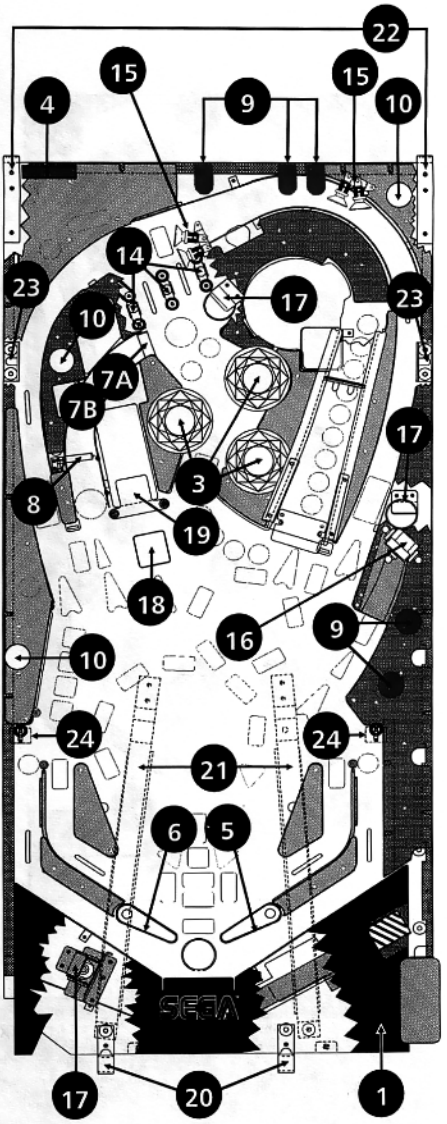
Nº	Above Playfield Part Name	SPI Part Nº
1	Bottom Arch Assembly (Metal)	500-6017-00-44
	ORDERING ABOVE (ITEM 1) ASSEMBLY PART Nº WILL INCLUDE:	
	Bottom Arch (Plain)	535-7294-01
	#6 X 3/8" PPH (Qty. 2)	232-5000-00
	#8 Washer (Qty. 2)	242-5005-00
	#8-32 X 3/8" HWH THRDFORM (Qty. 2)	237-5967-00
2 *	1 1/16" Steel Balls (Qty. 13) *	260-5000-00
3	Pop Bumper Cap Clear (Qty. 3)	550-5057-01
4	Jump Bumper Cap Red	545-5199-02
5	Right Flipper & Shaft Assy. White with Sonic the Hedgehog™ Logo	515-5133-01-03
6	Left Flipper & Shaft Assembly White with Sonic the Hedgehog™ Logo	515-5133-01-04
7A	1-Way Gate Mounting Bracket	535-5296-03
7B	1-Way Gate Wire	535-5307-03
8	Spinner Assembly	515-6253-00-44
	ORDERING ABOVE (ITEM 8) ASSEMBLY PART Nº WILL INCLUDE:	
	Spinner Bracket	535-7255-00
	Mini-Spinner	515-6250-00
	Micro Switch	180-5010-04
	Diode, 1N4001	112-5001-00
	#2-56 X 1/2" HWH Mach. SER (Qty. 2)	237-5937-00
	Cable Harness	036-5380-05
9	Mini-Mars Light Cover Red (Qty. 5)	550-5031-02
10	Mini-Mars Light Cover Clear (Qty. 3)	550-5031-01
11 *	Rubber Light Cover Red (Qty. 2) *	545-5014-02
12 *	Rubber Light Cover Yellow (Qty. 1) *	545-5014-06
13 *	Rubber Light Cover White (Qty. 3) *	545-5014-08
14	Top Lane Mini-Hoods Red (Qty. 3)	550-5061-02
15	Spot-Light Assembly (Qty. 2)	500-5818-01-44
	ORDERING ABOVE (ITEM 15) ASSY. PART Nº WILL INCLUDE:	
	Wdge Laydown Sckt. (Notched) (Qty. 2)	077-5026-01
	#555 Wedge Base Bulb (Qty. 2)	165-5002-00
	Bracket	535-6992-00
	Rivet ø 1/8" X 1/8 (Nickel)	249-5008-00
	Reflector (Qty. 2)	545-5409-01
	Cable Harness	036-5380-09
16	LEM Sub-Assembly	515-6417-00
	ORDERING ABOVE (ITEM 16) ASSY. PART Nº WILL INCLUDE:	
	LEM	545-5651-00
	LEM Mounting Bracket	535-7561-00
	#6 X 1/2" Screw	232-5001-00
	Laydown Wedge Socket	077-5026-01
	#555 Wedge Base Bulb	165-5002-00
	Rubber Lite Cover Red	545-5014-02
	Rivet ø 1/8"	249-5001-00
	Washer 5/16" ID X 9/64" OD X 1/32"	242-5017-00
17	Ball Snubber Bracket (Qty. 3)	535-7280-01
18	LED Plastic Cover Insert	550-5050-01
	FOR ALL PLASTIC LIGHT COVER INSERTS SEE APPENDIX H	
19	Rocket Ramp Flamp	535-7336-00

Nº	Below Playfield Part Name	SPI Part Nº
20	Playfield Hanging Bracket (Qty. 2)	535-5216-04
21	Playfield Support Bracket (Qty. 2)	535-6862-02
22	Edge Slide Bracket (Qty. 2)	535-5988-00
23	Pivot Pin Bracket Assembly (Qty. 2)	500-5329-00
	ORDERING ABOVE (ITEM 23) ASSY. PART Nº *WILL NOT* INCLUDE:	
	Pivot Bracket Screws (Qty. 4)	237-5907-00
	T-Nuts (Qty. 4)	240-5101-00
24	Adjustable Post Plate (Qty. 2)	535-5091-02

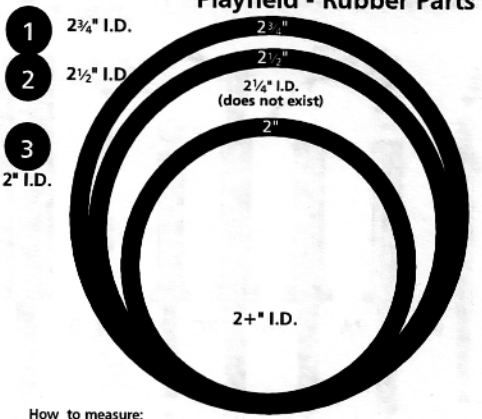
Note: For posts & rubbers see the next pages in this chapter.

Nº	The Playfield	SPI Part Nº
P1 *	Playfield Screened (No Parts) *	830-5144-00
P2 *	Playfield Complete with all Parts *	505-6004-44-44

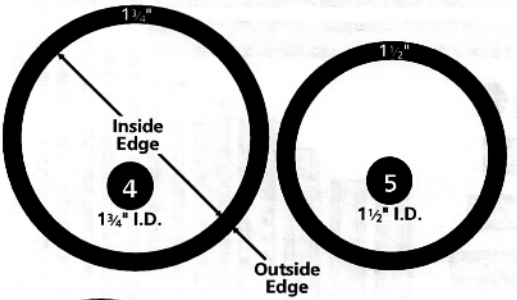
* - An asterisk indicates item is not noted in the illustration.

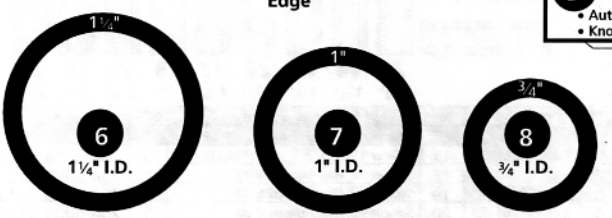


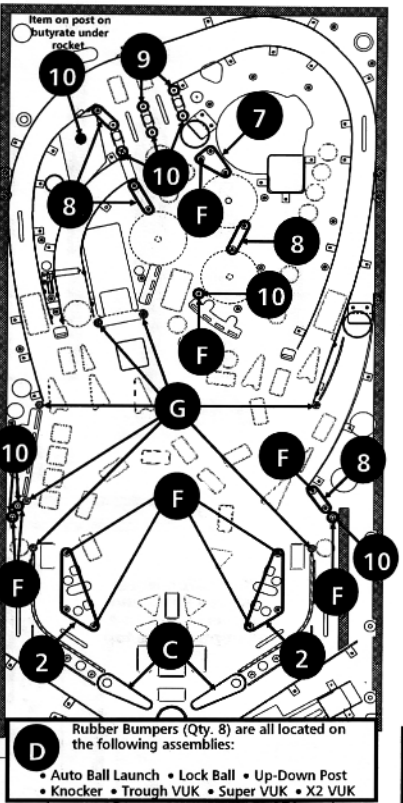
Playfield - Rubber Parts (Rings Actual Size) †



How to measure:
Lay ring over circle of closest size. *If you see the outside edge of the circle, **move to one ring smaller.** With the **correct size you will see the inside edge** of the circle around the inside of the rubber ring.* Please note: The rings will ***s t r e t c h*** with use. Always go to the size smaller. (I.D.=Inside Diameter; O.D.=Outside Diameter)







№	Rubber Part Name	QTY.	Part №	№	Rubber Part Name	QTY.	Part №
A	Rubber Bushing (Small)	0	545-5192-00	3	2" I.D. Black Rubber Ring	0	545-5348-08
B	Small Flipper Rubber Ring	0	545-5207-00	4	1¾" I.D. Black Rubber Ring	0	545-5348-21
C	Large Flipper Rubber Ring	2	545-5277-00	5	1½" I.D. Black Rubber Ring	0	545-5348-07
D	Rubber Bumper (Grommet)	8	545-5105-00	6	1¼" I.D. Black Rubber Ring	0	545-5348-06
E	Bumper Post Rubber	0	545-5009-00	7	1" I.D. Black Rubber Ring	1	545-5348-05
F	Post Rubber (Sleeve Short)	11	545-5151-00	8	¾" I.D. Black Rubber Ring	4	545-5348-04
G	Post Rubber (Sleeve Tall)	6	545-5308-00	9	5/16" I.D. Black Rubber Ring	2	545-5348-02
1	2¾" I.D. Black Rubber Ring	0	545-5348-20	10	3/16" I.D. Black Rubber Ring	9	545-5348-01
2	2½" I.D. Black Rubber Ring	2	545-5348-09	11	3/8" O.D. Black Rubber Ring	0	545-5348-19
				12	3" I.D. BLK Rubber Ring (Not Shown)	0	545-5348-10

Note: Size and/or quantities may change during production.

† Items with Ø Qty. are not used in this game.

Playfield - Metal Posts and Spacers (Actual Size) †

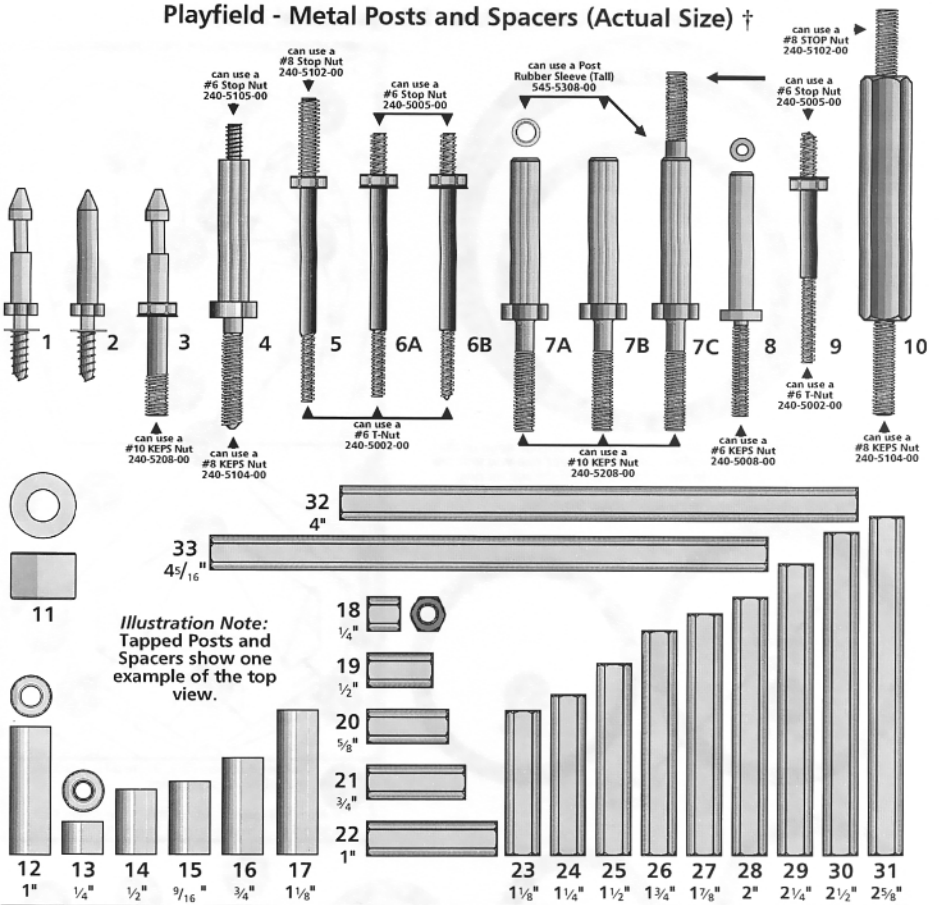


Illustration Note: Tapped Posts and Spacers show one example of the top view.

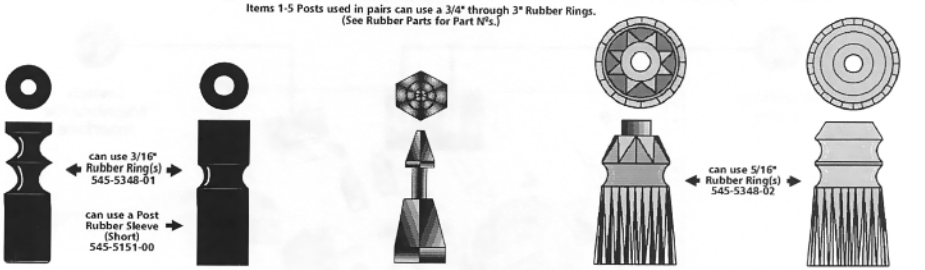
Nº	Metal Post/Spacer Name	QTY.	Part Nº	Nº	Metal Post/Spacer Name	QTY.	Part Nº
1	Mini-Post-Wood Threaded	0	530-5004-00	16	Spacer 3/4" Long X 5/16" X .144 I.D.	0	254-5014-01
2	Mini-Post-Wood Thd. No Cut-Away	0	530-5004-01	17	Spacer 1 1/8" Lg. X 5/16" X .144 I.D.	5	254-5014-02
3	Mini-Post-Machine Threaded	0	530-5005-00	18	Spacer 1/4" Hex Tapped 6-32	1	254-5008-00
4	Bumper Post -Machine Threaded	0	530-5007-00	19	Spacer 1/2" Hex Tapped 6-32	1	254-5008-03
5	Post Fastening Screw Lg. #8-32 Top	4	530-5008-00	20	Spacer 5/8" Hex Tapped 6-32	5	254-5008-02
6A	Post Machine Screw #6-32 Top	27	530-5012-02	21	Spacer 3/4" Hex Tapped 6-32	16	254-5008-04
6B	Post Wood Screw #6-32 Top	4	530-5010-02	22	Spacer 1" Hex Tapped 6-32	2	254-5008-06
7A	Bumper Post Hex Base #8-32 Tap.	0	530-5332-01	23	Spacer 1 1/8" Hex Tap. 6-32	6	254-5008-17
7B	Bumper Post Hex Base Untapped	7	530-5332-00	24	Spacer 1 1/4" Hex Tapped 6-32	1	254-5008-11
7C	Bumper Post Hex Base w/#8-32 Male	1	530-5332-02	25	Spacer 1 1/2" Hex Tapped 6-32	3	254-5008-09
8	Bumper Post 6-32 Tapped	0	530-5127-00	26	Spacer 1 3/4" Hex Tapped 6-32	2	254-5008-10
9	Post Machine Screw	0	530-5263-01	27	Spacer 1 7/8" Hex Tapped 6-32	0	254-5008-20
10	Mini-Playfield Support	0	530-5285-00	28	Spacer 2" Hex Tapped 6-32	0	254-5008-07
11	Spacer Backbox Hinge	2	530-5099-00	29	Spacer 2 1/4" Hex Tapped 6-32	0	254-5008-18
12	Spacer 1" Lg Metal 5/16" X .144 I.D.	0	254-5001-00	30	Spacer 2 1/2" Hex Tapped 6-32	0	254-5008-16
13	Spacer 1/4" Long X 5/16" X .144 I.D.	3	254-5014-03	31	Spacer 2 5/8" Hex Tapped 6-32	0	254-5008-08
14	Spacer 1/2" Long X 5/16" X .144 I.D.	5	254-5014-00	32	Spacer 4" Hex Tap. 6-32	0	254-5008-21
15	Spacer 9/16" Long X 5/16" X .144 I.D.	0	254-5014-04	33	Hex Spacer 4 5/16" X .144 I.D.	2	254-5018-00

† Items with Ø Qty. are not used in this game.

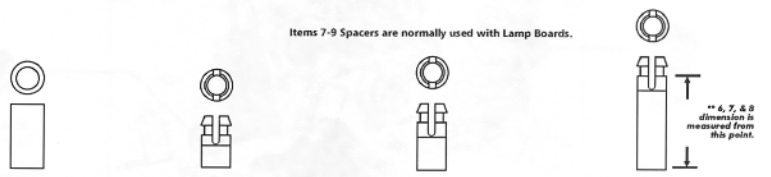
Note: Size and/or quantities may change during production.

Playfield - Plastic Posts and Spacers (Actual Size) †

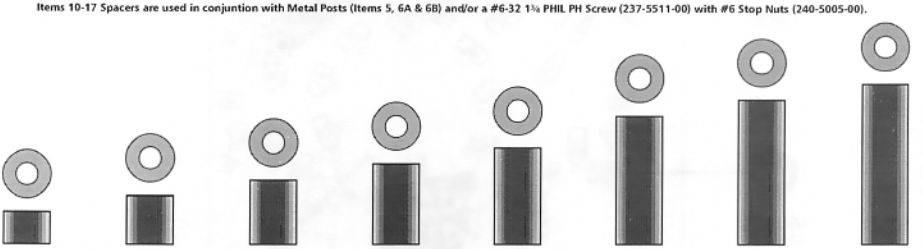
Items 1-5 Posts used in pairs can use a 3/4" through 3" Rubber Rings.
(See Rubber Parts for Part Nºs.)


can use 3/16" Rubber Ring(s) 545-5348-01
can use a Post Rubber Sleeve (Short) 545-5151-00
can use 5/16" Rubber Ring(s) 545-5348-02
1
2
3 * * Various Colors
4 * * Various Colors
5 * * Various Colors

Items 7-9 Spacers are normally used with Lamp Boards.



Items 10-17 Spacers are used in conjuntion with Metal Posts (Items 5, 6A & 6B) and/or a #6-32 1¾ PHIL PH Screw (237-5511-00) with #6 Stop Nuts (240-5005-00).



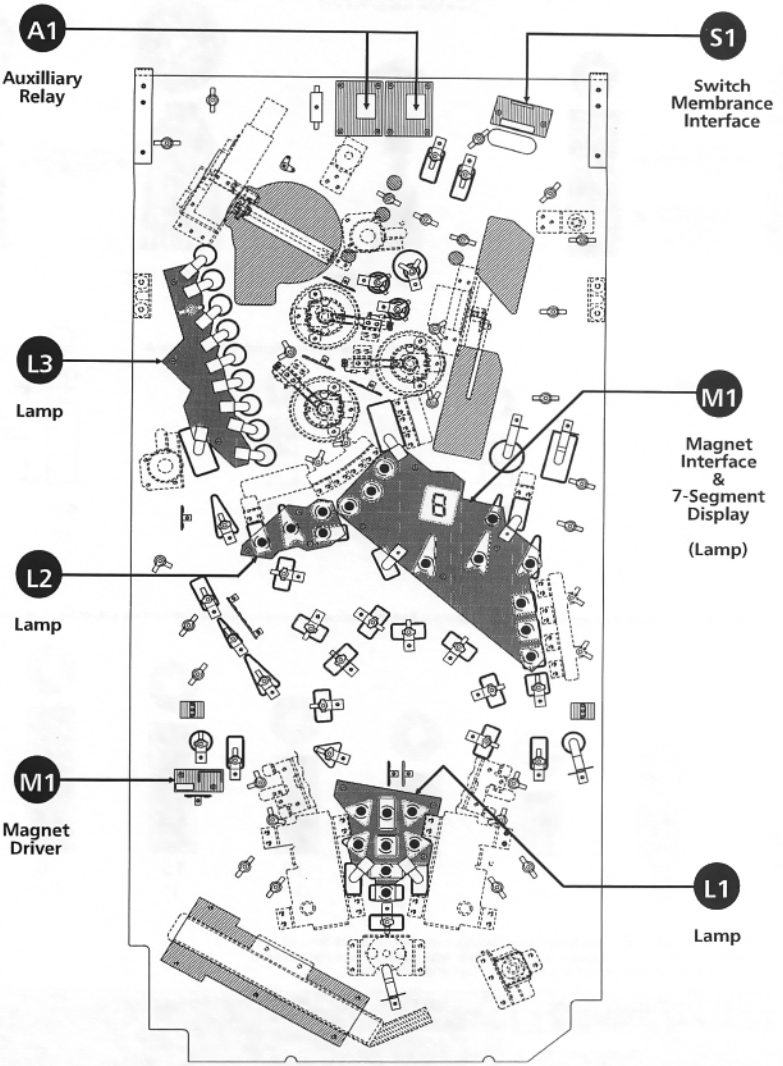
* For various colors of these items (Jewel Posts), see Color Chart at the end of Section 4, Chapter 2. Replace the last 2-digits with desired color replacement.
** Dimension is measured from bottom to just under cut-away.

Nº	Plastic Post/Spacer Name	QTY.	Part Nº	Nº	Plastic Post/Spacer Name	QTY.	Part Nº
1	Stand-Off Double Groove 1-1/16"	0	530-5102-01	9 **	Spacer 3/4" Plastic Slf. Rtn. SRS6-12-01	0	254-5007-03
2	Plastic Post (Black)	46	550-5059-00	10	Spacer 1/4" Plastic 3/8" (Gray)	0	254-5000-02
3 *	Mini-Jewel Post	0	550-5052-XX	11	Spacer 3/8" Plastic 3/8" (Gray)	0	254-5000-12
4 *	Small Jewel Post	0	550-5034-XX	12	Spacer 1/2" Plastic (Gray) 3/8"	0	254-5000-01
5 *	Double Rubber Jewel Post (Red)	1	545-5209-02	13	Spacer 5/8" Plastic 3/8" (Gray)	0	254-5000-14
6	Spacer 1/2" Plstc. Narrow (White) 3/8"	0	254-5000-03	14	Spacer 3/4" Plastic 3/8" (Gray)	0	254-5000-07
7 **	Spacer 1/4" Plastic Slf. Rtn. SRS6-4-01	4	254-5007-02	15	Spacer 1" Plastic 3/8" (Gray)	0	254-5000-04
8 **	Spacer 3/8" Plastic Slf. Rtn. SRS6-6-01	12	254-5007-01	16	Spacer 1 1/8" Plastic 3/8" (Gray)	0	254-5000-06
				17	Spacer 1 1/4" Plastic 3/8" (Gray)	0	254-5000-05

Note: Size and/or quantities may change during production.

† Items with Ø Qty. are not used in this game.

Playfield - Boards: Lamp, 7-Segment Display, Magnet Interface, Auxillary Relay, Switch Membrane Interface & Magnet Driver †



Nº	Board Name	SPI Part Nº	Nº	Board Name	SPI Part Nº
L1 *	Lamp Board	520-5130-01	M1*	Magnet Interface & 7-Segment Display Bd	520-5130-06
L2 *	Lamp Board	520-5130-04	M2	Magnet Driver Board	520-5130-02
L3 *	Lamp Board	520-5130-05	S1	Switch Membrane Interface Board	520-5130-03
			A1	Aux. Relay Board (Qty. 2)	520-5010-00

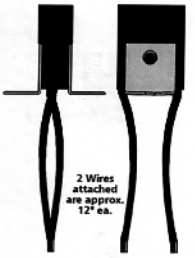
*Note: #555 & #906 Bulbs are used on the Lamp Boards.
See the next page for bulb & socket part numbers.

Playfield - Wedge Base Type Bulbs and Sockets (Actual Size) †

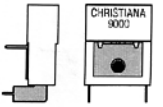
A
#555

1
This socket is normally used on Lamp Boards to position bulbs vertically. (Use w/#555 & #906 Bulbs.)

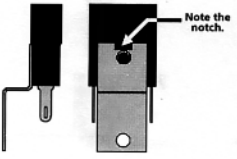
2
This socket is normally used in Pop Bumpers. (Use #555 Bulbs only.)



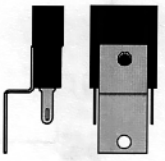
3
This socket is normally used on Lamp Boards to position bulbs horizontally. (Use w/#555 & #906 Bulbs.)

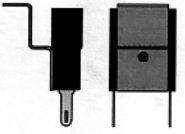


4
This socket is normally used with Reflectors.



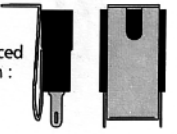
5





6

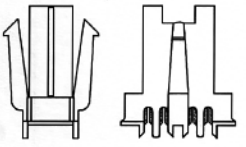
replaced with :



B
#906

7
This socket is sometimes used in conjunction with Mini-Mars or special Butyrate assemblies.

8
This socket was used with an alternate insert using Insulation Displacement Connection vs. a Soldered-On Connection.



C
Neon

This Neon Bulb is used in Motor Assemblies for voltage spike suppression.

Nº	Bulb & Socket Name	QTY.	Part Nº
A	#555 Wedge Base Bulb	32	165-5002-00
1	555 Wedge Base Socket	22	077-5007-00
2	Turbo Pop Bumper Socket (New)	3	077-5206-00
3	Lamp Board Laydown Wedge Base	15	077-5207-00
4	Laydown Wedge Base L/R Black	7	077-5026-01
5	Laydown Wedge Base Black	0	077-5026-00
6	Wedge Offset Brckt. Socket 2-Styles	0	077-5029-00

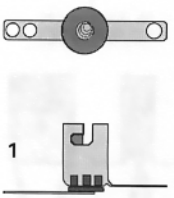
Nº	Bulb & Socket Name	QTY.	Part Nº
B	#906 Wedge Base Bulb	15	165-5004-00
7	906 Wedge Base Socket	0	077-5016-00
8	555/906 IDC Wedge Socket	0	077-5110-00

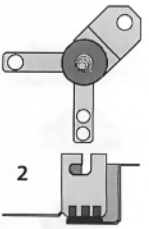
Nº	Bulb Name (Used in Motors)	QTY.	Part Nº
C	Neon NE-2 Bulb	2	165-5021-00

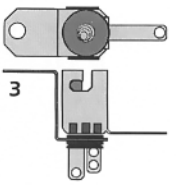
† items with Ø Qty. are not used in this game.

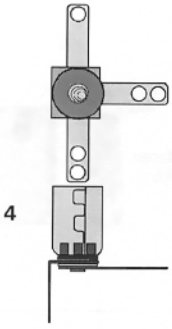
Note: Size and/or quantities may change during production.

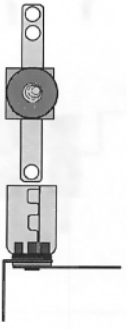
Playfield - Bayonet Type Bulbs and Sockets (Actual Size) †

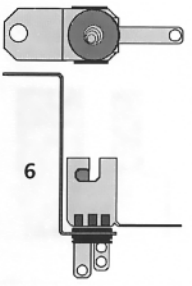


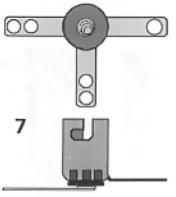


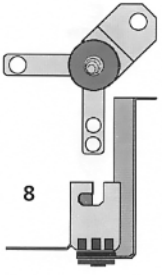




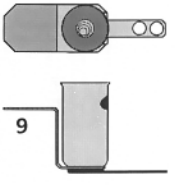








This bulb is normally used in conjunction with socket 9, but can be used with sockets 1-8.

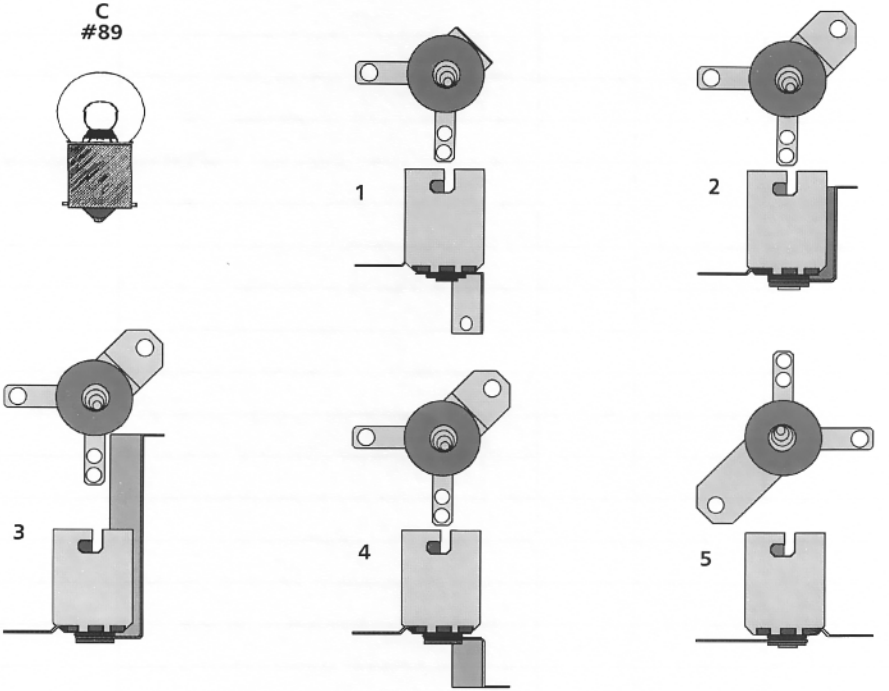


Nº	Bulb & Socket Name	QTY.	Part Nº	Nº	Bulb & Socket Name	QTY.	Part Nº
A	#44 Bulb	97	165-5000-44	6	3-Lug Stand-Up Long Socket	28	077-5009-00
1	2-Lug Staple Down Socket	64	077-5000-00	7	3-Lug Staple Down Socket	1	077-5001-00
2	2-Lug Stand-Up Short Socket	0	077-5002-00	8	2-Lug Stand-Up Long Socket	0	077-5005-00
3	3-Lug Stand-Up Short Socket	0	077-5008-00				
4	3-Lug Laydown Socket	5	077-5006-00	B	#455 Twinkle Bulb	1	165-5003-00
5	2-Lug Laydown Socket	0	077-5003-00	9	1-Lug Stand-Up Long Socket	0	077-5012-00

† Items with Ø Qty. are not used in this game.

Note: Size and/or quantities may change during production.

Playfield - Large Bayonet Type Bulbs and Sockets (Actual Size) †



† Items with Ø Qty. are not used in this game.

Nº	Bulb & Socket Name	QTY.	Part Nº	Nº	Bulb & Socket Name	QTY.	Part Nº
C	#89 Bulb	21	165-5000-89	3	Stand-Up, Long Socket	3	077-5102-00
1	Laydown Standard Socket	2	077-5100-00	4	Stand-Up, Socket Rev. Short	0	077-5103-00
2	Stand-Up, Short Socket	15	077-5101-00	5	Straight Leg Socket	1	077-5107-00

Note: Size and/or quantities may change during production.

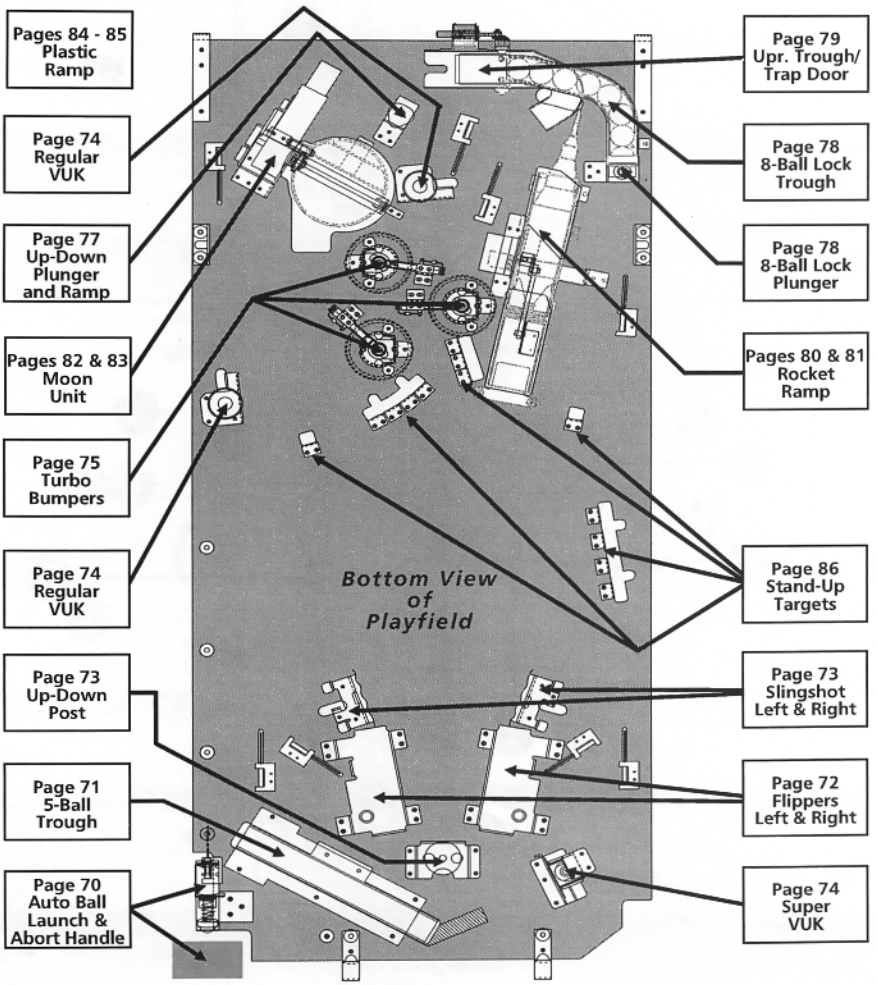
Parts Order Checklist Notes

Date Ordered	Part Nº	Qty.	Description	Date Received

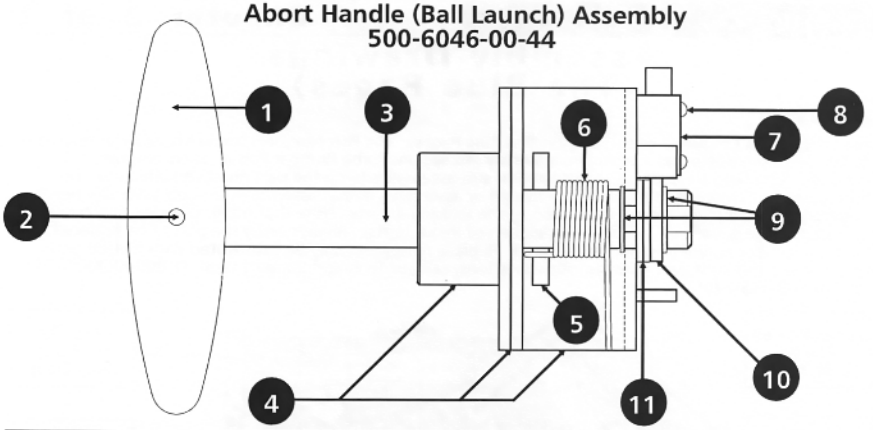
Assembly Drawings (The Blue Pages)

Overview

This chapter expands Chapter 1 of this section (The Pink Pages). The Part Numbers for all Major Assemblies are provided and can be ordered as a complete assembly (exception: Turbo Bumper Parts). Each assembly is broken down, describing the individual parts and/or sub-assemblies (with the part numbers) which can be ordered separately. Where multiple parts are riveted or assembled as sub-assemblies the sub-assembly needs to be ordered. The drawings show the location of the individual parts. Note that minor changes may be made during production (e.g. coil size, addition or deletion of minor parts). Always verify the part to be replaced with the part number and/or description as noted. Replacement parts may be substituted with revised parts which may have a different part number. Any questions, call our Technical Support Dept. (1-800-KICKERS USA & Canada or 708-345-7700).

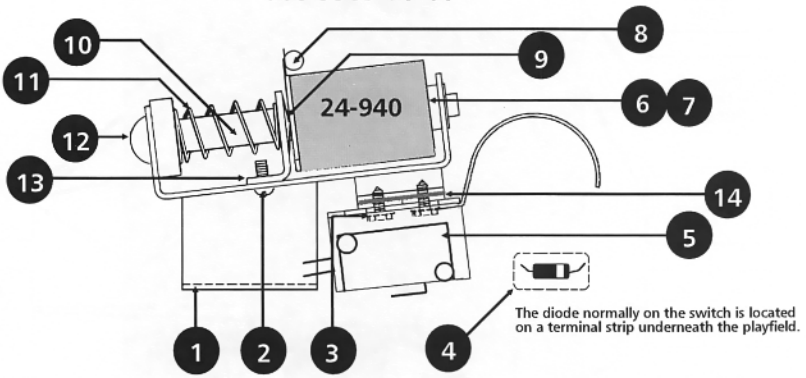

Pages 84 - 85 Plastic Ramp
Page 74 Regular VUK
Page 77 Up-Down Plunger and Ramp
Pages 82 & 83 Moon Unit
Page 75 Turbo Bumpers
Page 74 Regular VUK
Page 73 Up-Down Post
Page 71 5-Ball Trough
Page 70 Auto Ball Launch & Abort Handle
Page 79 Upr. Trough/ Trap Door
Page 78 8-Ball Lock Trough
Page 78 8-Ball Lock Plunger
Pages 80 & 81 Rocket Ramp
Page 86 Stand-Up Targets
Page 73 Slingshot Left & Right
Page 72 Flippers Left & Right
Page 74 Super VUK
Bottom View of Playfield

Abort Handle (Ball Launch) Assembly
500-6046-00-44



Nº	Part Name	SPI Part Nº	Nº	Part Name	SPI Part Nº
1	"T" Style Handle	545-5644-00	8	#4-40 X 5/8" HWHTF (Qty. 2)	237-5945-00
2	1/8" X 5/8" Roll Pin	251-5008-00	9	7/16" E-Ring	270-5018-00
3	Shaft	530-5401-00	10	CAM	535-7623-00
4	Hub (Front & Back Plate) Assembly	515-6491-00	11	7/16" I.D. Nylon Washer (Qty. 2)	242-5041-00
5	1/8" X 1" Roll Pin	251-5016-00	Nº	Associated Part Name	SPI Part Nº
6	Torsion Spring	265-5042-00	n/a	Mounting Screws #6 X 1/2" (Qty. 4)	234-5001-02
7	"D4" Switch	180-5061-00	n/a	Fire Switch Cable	036-5380-11

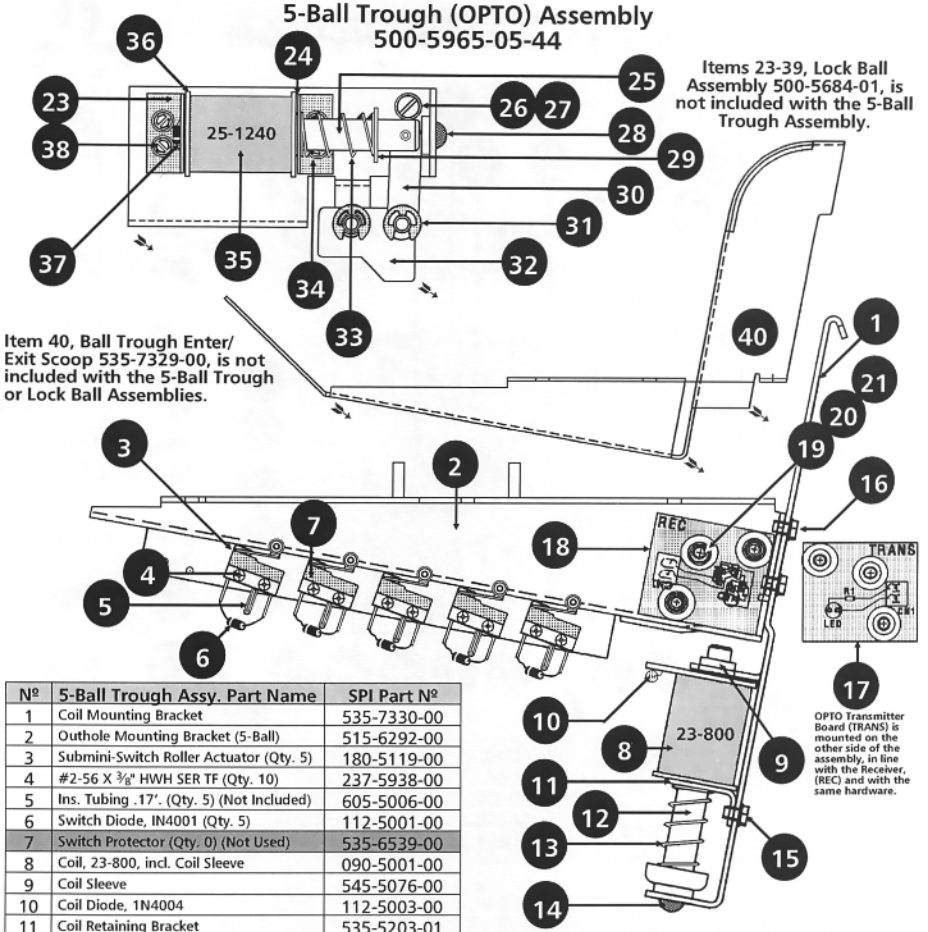
Auto Ball Launch (Shooter Lane) Assembly
500-5969-01-44



Nº	Part Name	SPI Part Nº	Nº	Part Name	SPI Part Nº
1	Shooter Mounting Bracket	535-7331-01	8	Coil Diode, 1N4004	112-5003-00
2	8-32 X .25" PPH SEMS (Qty. 2)	232-5300-00	9	.531" ID X .75" OD X .01 THK.	269-5002-00
3	#6 X 3/8" HWH SMS (Qty. 2)	234-5000-00	10	Plunger Assembly	515-5000-02
4 *	Switch Diode, 1N4001	112-5001-00	11	Compression Spring	266-5020-00
5	Micro Switch Assembly	515-6514-00	12	Rubber Bumper (Grommet)	545-5105-00
6	Coil, 24-940, incl. Coil Sleeve	090-5036-01	13	Coil Retaining Bracket	535-5203-03
7	Coil Sleeve	545-5076-00	14	Shock Pad	545-5640-00

* Item 4 is not included with this assy. Diode is located in cabinet.

5-Ball Trough (OPTO) Assembly
500-5965-05-44

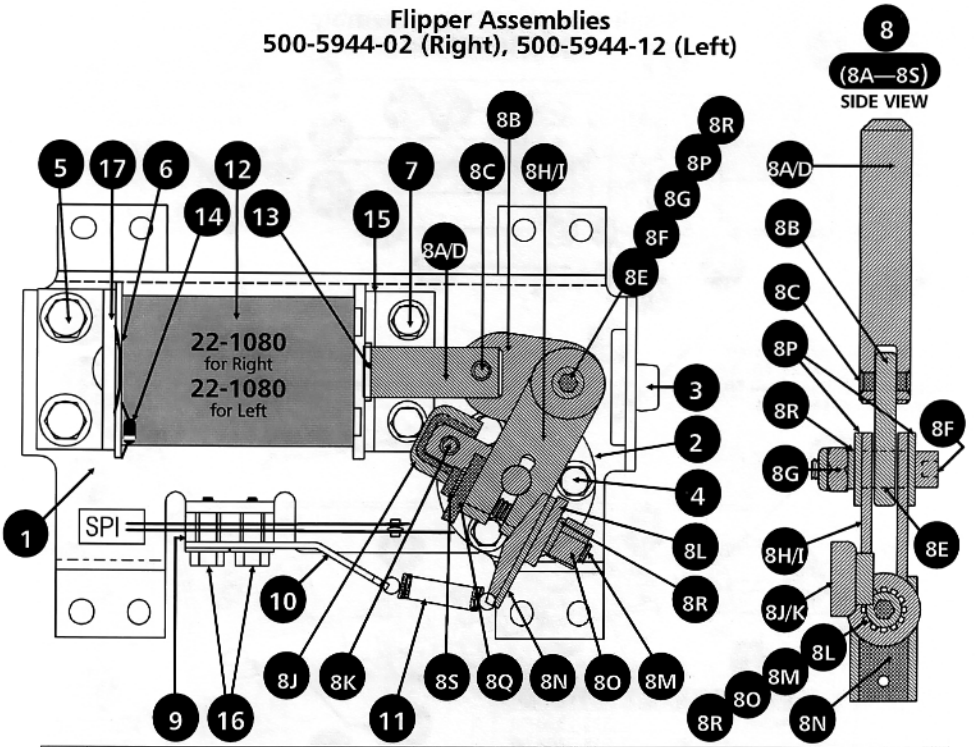

25-1240
Items 23-39, Lock Ball Assembly 500-5684-01, is not included with the 5-Ball Trough Assembly.
Item 40, Ball Trough Enter/ Exit Scoop 535-7329-00, is not included with the 5-Ball Trough or Lock Ball Assemblies.
REC
TRANS
LED
23-800
OPTO Transmitter Board (TRANS) is mounted on the other side of the assembly, in line with the Receiver, (REC) and with the same hardware.

Nº	5-Ball Trough Assy. Part Name	SPI Part Nº
1	Coil Mounting Bracket	535-7330-00
2	Outhole Mounting Bracket (5-Ball)	515-6292-00
3	Submini-Switch Roller Actuator (Qty. 5)	180-5119-00
4	#2-56 X 3/8" HWH SER TF (Qty. 10)	237-5938-00
5	Ins. Tubing .17'. (Qty. 5) (Not Included)	605-5006-00
6	Switch Diode, IN4001 (Qty. 5)	112-5001-00
7	Switch Protector (Qty. 0) (Not Used)	535-6539-00
8	Coil, 23-800, incl. Coil Sleeve	090-5001-00
9	Coil Sleeve	545-5076-00
10	Coil Diode, 1N4004	112-5003-00
11	Coil Retaining Bracket	535-5203-01
12	Plunger Assembly	515-5941-01
13	Compression Spring	266-5020-00
14	Rubber Bumper (Grommet)	545-5105-00
15	#8-32 X .25" HWH SER MS (Qty. 2)	237-5964-00
16	#8-32 X 3/8 HWH TF (Qty. 4)	237-5967-00
17	OPTO Transmitter (TRANS) Board	520-5124-00
18	OPTO Receiver (REC) Board	520-5125-00
19	OPTO PCB Tube Spacer (Qty. 6)	530-5308-02
20	OPTO PCB Rubber Grommet (Qty. 6)	545-5518-00
21	#6-32 X 5/8" HWH TF (Qty. 6)	237-5928-00
22 *	Ball Trough Wire Harness (Not Shown)	036-5386-05
Nº	Lock Ball Assembly Part Name	SPI Part Nº
23	Core Stop Assembly	515-5088-00
24	Lock Ball Bracket Assembly	515-5817-01
25	Plunger ø7/16" X 2.25" LG	530-5250-01

Nº	Lock Ball Assy. Part Name	SPI Part Nº
26	Plastic Spacer	545-5400-00
27	#8-32 PPH X 1" LG	232-5606-00
28	Rubber Bumper (Grommet)	545-5105-00
29	Retaining Ring 7/16" ø Shaft	270-5005-00
30	Link, Lock Ball	545-5058-00
31	Retaining Ring, 1/4" ø (Qty. 2)	270-5002-00
32	Lock Ball Cam Assembly	515-5815-01
33	Compression Spring	266-5000-00
34	Coil Retaining Bracket	535-6658-00
35	Coil, 25-1240, incl. Coil Sleeve	090-5034-00
36	Coil Sleeve	545-5411-00
37	Coil Diode, 1N4004	112-5003-00
38	#6-32 HWH TC X .38 LG (Qty. 4)	237-5898-00
39 *	Lock Ball Wiring Harness (Not Shown)	036-5301-01
40	Ball Trough Enter/Exit Scoop	535-7329-01

Note: An asterisk (*) indicates item is not depicted in pictorial.

Flipper Assemblies
500-5944-02 (Right), 500-5944-12 (Left)



Nº	Part Name	SPI Part Nº
1	Flipper Base (-00 Right; -01 Left)	535-7275-XX **
2	Flipper Bushing	545-5594-00
3	Bumper	545-5428-00
4	#6-32 X .38" Lg. HWH TF SERR (Qty.3)	237-5910-01
5	#10-32 X .38" Lg. HWH TF SERR (Qty. 2)	237-5961-00
6	Spring Washer	269-5002-00
7	#8-32 X .38 Lg. HWH TF (Qty. 2)	237-5967-00
8	Plunger/Pawl Sub-Assy. (-00 Rt.; -01 Lt.)	515-6518-XX **
ORDERING ABOVE (ITEM 8) SUB-ASSEMBLY PART Nº WILL INCLUDE:		
8A	Flipper Plunger/Link Assembly (ordering A includes B-D)	515-6304-01
8B	Flipper Link	545-5611-00
8C	Spirol Pin ø.156 X 1/2" Lg.	251-5015-00
8D	Flipper Plunger with Flat	530-5349-01
8E	Extended Flipper Bushing	530-5139-01
8F	#10-32 X 7/8" Lg. SOC HD	237-5966-00
8G	#10-32 Nylon Stop Nut	240-5203-00
8H	Flipper Mounting Link (Pawl) Sub-Assy. (ordering H includes I-K)(-00 Rt.; -01 Lt.)	515-6305-XX **
8I	Flipper Mounting Link (-00 Rt.; -01 Lt.)	535-7271-XX **
8J	Switch Actuator	545-5612-00
8K	Rivet 1/8" ø X 1/4" Lg.	249-5003-00
8L	Washer .105" THK .203" I.D. X .63" O.D.	242-5039-00
8M	#10-32 SOC HD X 1.25" Lg. (Qty. 2)	237-5950-00
8N	Return Bracket	535-7353-00
8O	#10-32 X 9/32" Long 3/8" Hex Nut	240-5209-00
8P	Wshr. .06" THK (same I.D./O.D.) (Qty. 2)	242-5038-00
8Q	Washer .105" THK .203" I.D. X .63" O.D.	242-5039-01
8R	#10-32 Split Lock Washer (Qty. 2)	244-5003-00
8S	#10 Star Washer	246-5002-00

Nº	Part Name	SPI Part Nº
9	Power (End of Stroke) Switch	180-5149-00
10	Switch Plate/Spring Return Bracket	535-7354-00
11	Flipper Return Spring	265-5035-00
12	Coil 22-1080 (YEL-GRN) incl. Coil Sleeve	090-5032-00
13	Coil Sleeve	545-5388-00
14	Coil Diode, 1N4004	112-5003-00
15	Coil Support Bracket	535-7356-00
16	#6-32 X .63" HWH TF (Qty.2)	237-5928-00
17	Coil Stop Sub-Assembly (w/ø.093" Hole)	515-6308-01
ORDERING ABOVE (ITEM 17) SUB-ASSEMBLY PART Nº WILL INCLUDE:		
—	Coil Stop with Hole	530-5350-00
—	Shading Ring	530-5123-00
—	Coil Stop Bracket	535-7355-00

** ***NOTE:*** When ordering a part for the Right Assembly replace the "-XX" with "-00"; for the Left Assembly replace the "-XX" with "-01".

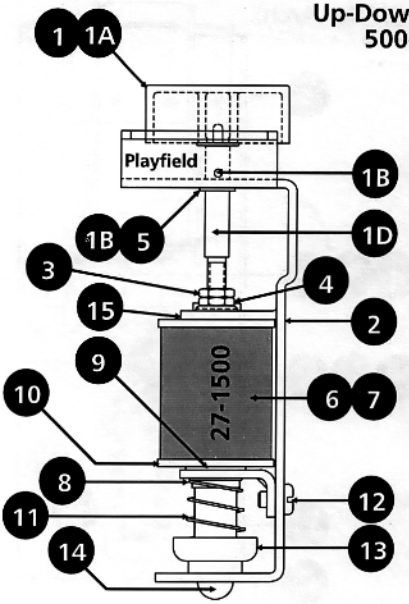
IMPORTANT: WHEN REPLACING ITEM 8B, FLIPPER LINK, WE ADVISE REPLACING WITH ENTIRE ITEM 8A, FLIPPER PLUNGER/LINK ASSEMBLY DUE TO OVERALL WEAR & TEAR.

*** ***CHECK ALL OTHER COMPONENTS AND REPLACE AS REQUIRED*** ***

ASSOCIATED PART(S) NOT INCLUDED WITH THE ABOVE ASSEMBLY

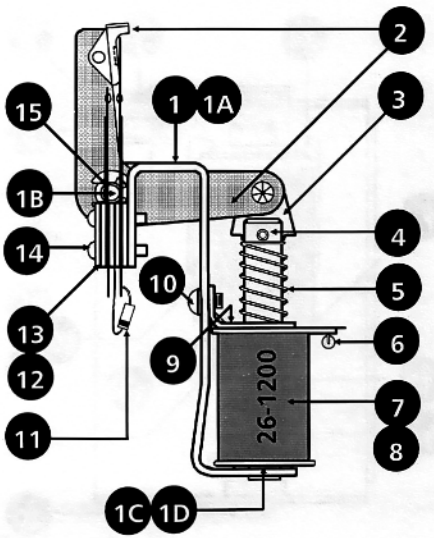
Nº	Associated Part Name	SPI Part Nº
n/a	Right Flipper Bat & Shaft Assembly Color: WHITE W/SONIC THE HEDGEHOG™ LOGO	515-5133-01-03
n/a	Left Flipper Bat & Shaft Assembly Color: WHITE W/SONIC THE HEDGEHOG™ LOGO	515-5133-01-04

Up-Down Post Assembly
500-6023-00-44



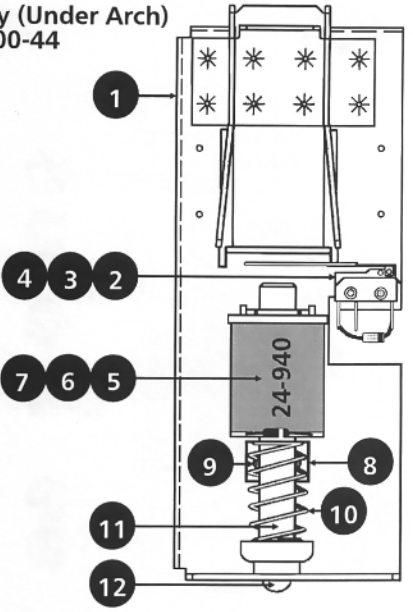
Nº	Part Name	SPI Part Nº
1	Up-Down Shaft Sub-Assembly	515-6418-00
ORDERING ABOVE (ITEM 1) SUB-ASSEMBLY PART Nº WILL INCLUDE:		
A	Bumper (Red)	550-5029-02
B	3/32" X 1/2" Roll Pin	251-5002-00
C	Retaining Ring 1/4" ø Shaft	270-5002-00
D	Up-Down Shaft	530-5376-00
2	Up-Down Mounting Bracket	535-7505-01
3	#10-32 Hex Jam Nut	240-5201-00
4	#10-32 Keps Nut	240-5208-00
5	Nylined Bearing 1/4" Shaft	545-5050-00
6	Coil 27-1500, incl. Coil Sleeve	090-5004-00
7	Coil Diode, 1N4004	112-5003-00
8	Coil Sleeve	545-5076-00
9	Spring Washer	269-5002-00
10	Coil Retaining Bracket	535-5203-01
11	Spring	266-5022-01
12	#8-32 X 1/4" Mach. Screw P-PH SEMS (Qty. 2) *Note: If replaced, apply loctite before installation.*	232-5300-00
13	Plunger Assembly	515-6439-00
14	Rubber Bumper (Grommet)	545-5105-00
15	Coil Insulator	545-5431-00

Slingshot Assemblies
500-5849-01 (Right & Left)



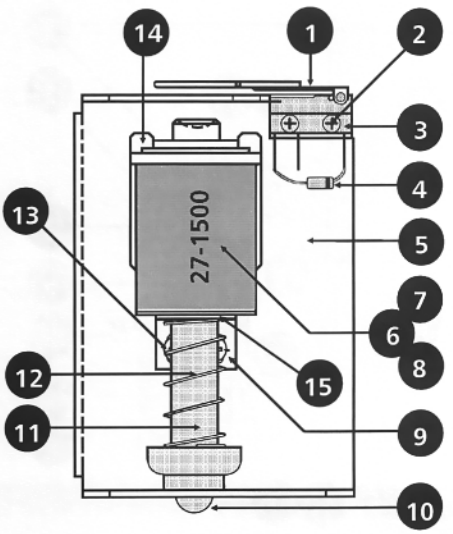
Nº	Part Name	SPI Part Nº
1	Slingshot Bracket Assembly	515-5339-01
ORDERING ABOVE (ITEM 1) SUB-ASSEMBLY PART Nº WILL INCLUDE:		
A	Slingshot Bracket	535-5919-01
B	Hinge Stud	530-5034-01
C	Armature Stop	530-5017-01
D	Shading Ring	530-5307-00
2	Arm & Tip Assembly	515-5340-01
3	Armature Link	545-5062-00
4	Plunger & Link Assembly	515-5338-00
5	Compression Spring	266-5020-00
6	Coil Diode, 1N4004	112-5003-00
7	Coil 26-1200, incl. Coil Sleeve	090-5044-00
8	Coil Sleeve	545-5031-00
9	Coil Retaining Bracket	535-5203-03
10	#8-32 X 1/4" Screw (Qty. 2)	232-5300-00
11	Switch Diode, 1N4001	112-5001-00
12	Slingshot Switch (Qty. 2)	180-5054-00
13	Tension Switch Plate (Qty. 2)	535-7344-00
14	#6-32 X 3/4" HWH (SER) Zinc (Qty. 4)	237-5958-00
15	Retaining Ring 1/4" ø (Qty. 2)	270-5002-00

Super VUK Assembly (Under Arch)
500-5880-00-44



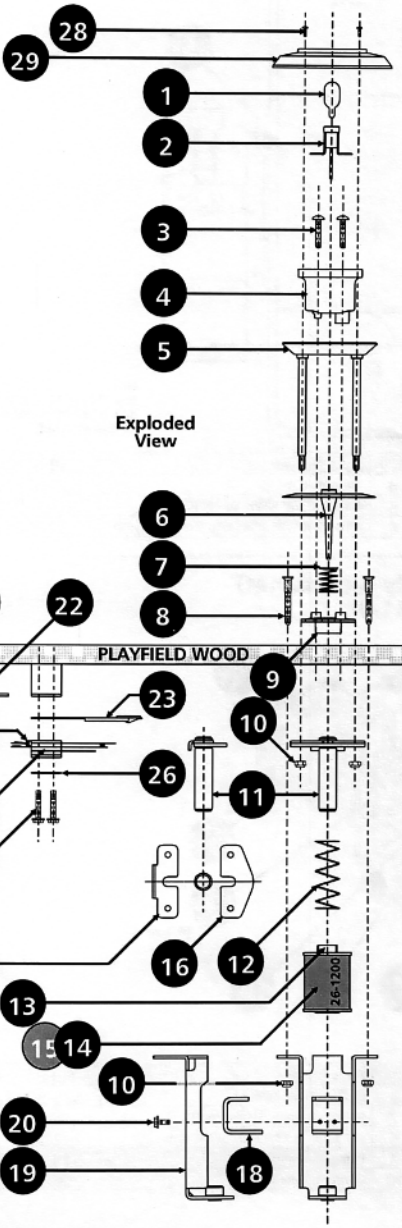
№	Part Name	SPI Part №
1	Super VUK Weld Assembly	515-6123-00
2	Micro Switch (Loop Type)	180-5116-00
3	#2-56 X 1/2" HWHS MS TF (Qty. 2)	232-5937-00
4	Switch Diode, 1N4001	112-5001-00
5	Coil, 24-940, incl. Coil Sleeve	090-5036-01
6	Coil Sleeve	545-5076-00
7	Coil Diode, 1N4004	112-5003-00
8	Coil Retaining Bracket	535-5203-01
9	#8-32 X 1/4" PPH (Lock-Tite) (Qty. 2)	232-5300-00
10	Compression Spring	266-5020-00
11	Plunger Assembly	515-5941-01
12	Rubber Bumper (Grommet)	545-5105-00

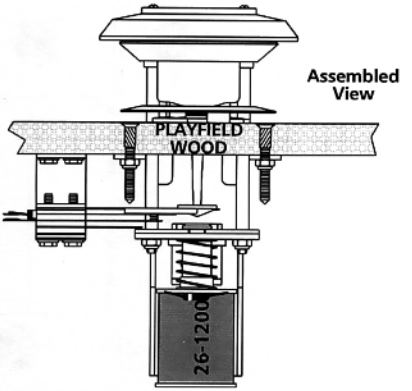
Regular VUK Assemblies (Right & Center Ball Ejects)
500-5839-02-44



№	Part Name	SPI Part №
1	Micro Switch (Loop Type)	180-5116-00
2	#2-56 X 1/2" HWH (Qty. 2)	237-5937-00
3	Switch Body Protect Plate	535-6539-00
4	Switch Diode, 1N4001	112-5001-00
5	VUK Bracket	535-6607-00
6	Coil 27-1500, incl. Coil Sleeve	090-5004-01
7	Coil Sleeve	545-5076-00
8	Coil Diode, 1N4004	112-5003-00
9	Coil Mounting Bracket	535-5203-03
10	Rubber Bumper (Grommet)	545-5105-00
11	Compression Spring	266-5020-00
12	Plunger Assembly	515-5941-01
13	#8-32 X 1/4" PPH (Lock-Tite) (Qty. 2)	232-5300-00
14	Coil Insulation	545-5431-00
15	Crescent Spring Washer	269-5002-00

Turbo Bumper Individual Parts
(Not available as an assembly. Parts are grouped for easy reference.)





TOP GROUP

Nº	Part Name	SPI Part Nº
1	#555 Wedge Base Bulb	165-5002-00
2	#555 Wedge Base Socket	077-5206-00
3	#5 X 7/8" PH RH (AB) (Qty. 2)	237-5826-00
4	Bumper Body	545-5197-00
5	Ring Assembly	515-5085-00
6	Bumper Skirt	545-5607-00
7	Bumper Skirt Spring	266-5048-00
8	#6-32 X 1-3/16" Spiral Shank (Qty. 3)	237-5957-00
9	Bumper Base	545-5195-00
10	#6-32 Nylon Stop Nut (Qty. 5)	240-5005-00

BOTTOM GROUP

Nº	Part Name	SPI Part Nº
11	Plunger	530-5348-00
12	Coil Spring	266-5047-00
13	Coil Sleeve	545-5031-00
14	Coil 26-1200, incl. Coil Sleeve	090-5044-00
15	Coil Diode, 1N4004 (Not Shown)	112-5003-00
16	Fiber Yoke	545-5609-00
17	Metal Yoke	535-7346-00
18	Metal Yoke Stop	535-7347-00
19	Coil Bracket Sub-Assembly	515-5939-00
20	#6-32 X 1/4" HWHTF (SERR) (Qty. 2)	237-5952-00

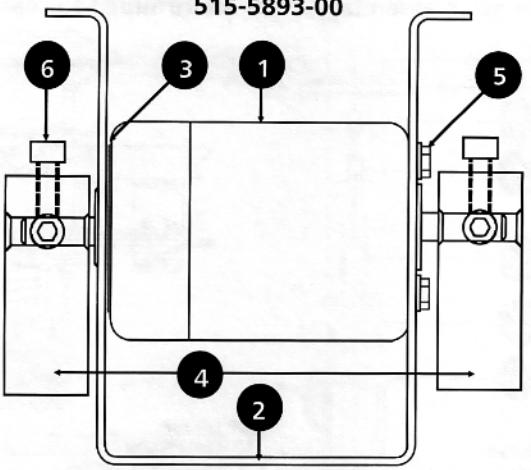
SWITCH GROUP

Nº	Part Name	SPI Part Nº
21	#6 X 1/2" HWH (AB) (Qty. 2)	234-5001-02
22	Switch Bracket	535-7342-00
23	Spoon Switch Actuator	545-5610-01
24	Stack Switch	180-5015-03
25	Switch Diode, 1N4001	112-5001-00
26	Switch Plate	535-7344-00
27	#6-32 X 3/4" HWHMS (SERR) (Qty. 2)	237-5958-00

ASSOCIATED GROUP

Nº	Part Name	SPI Part Nº
28	#4 X 3/4" PH RH (T25) (Qty. 2)	237-5873-00
29	Plastic Bumper Cap Cover (Qty. 3) This game the "-XX" should be replaced with: "-02" Red. See the Plastic Part Color Chart at the end of this chapter for alternate color choices.	550-5057-XX

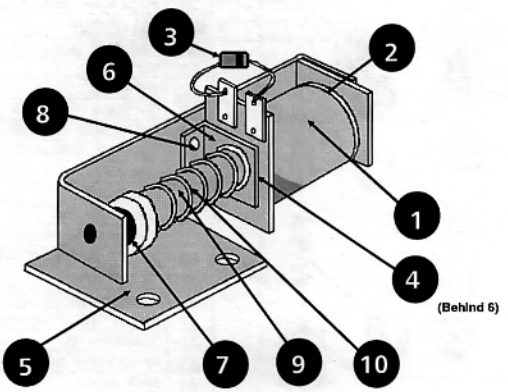
Shaker Motor Assembly (In Cabinet)
515-5893-00



Note:
The Shaker Motor Board, 515-5742-00 is not a part of this assembly.

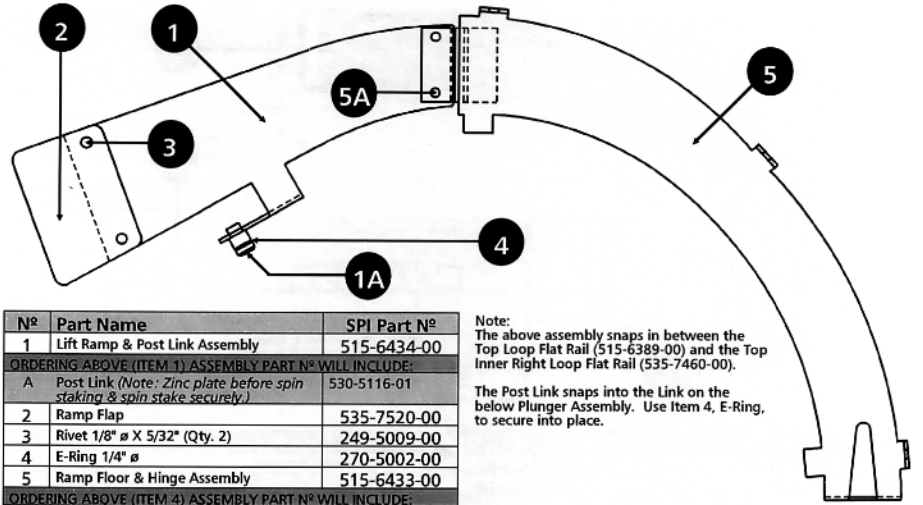
№	Part Name	SPI Part №	№	Part Name	SPI Part №
1	Shaker (Vibrator) Motor	041-5029-00	4	Weights (Qty. 2)	535-6727-00
2	Shaker Motor Bracket	535-6711-00	5	#8-32 X 3/8" HWH Screw (Qty. 2)	237-5903-00
3	Insulator	545-5425-00	6	#10-32 X 1/2" SCHS Cap Screw (Qty. 4)	237-5904-00

Knocker Assembly (In Cabinet)
500-5081-00



№	Part Name	SPI Part №	№	Part Name	SPI Part №
1	Coil 23-800, incl. Coil Sleeve	090-5001-01	6	Coil Retainer Bracket	535-5203-03
2	Coil Sleeve	545-5076-00	7	Rubber Bumper (Grommet)	545-5105-00
3	Coil Diode, 1N4004	112-5003-00	8	#8-32 X ¼ " PH PAN SEMS (Qty. 2)	232-5300-00
4	Crescent Spring Washer	269-5002-00	9	Plunger Assembly	515-5000-02
5	Kickback/Knocker Bracket	535-5265-00	10	Compression Spring	266-5020-00

Up-Down Metal Ramp Assy. (Operated by Up-Down Ramp Plunger Assy.) 500-6042-00-44

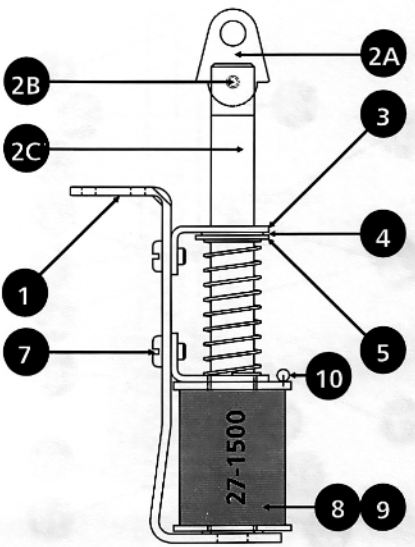


Nº	Part Name	SPI Part Nº
1	Lift Ramp & Post Link Assembly	515-6434-00
ORDERING ABOVE (ITEM 1) ASSEMBLY PART Nº WILL INCLUDE:		
A	Post Link *(Note: Zinc plate before spin staking & spin stake securely.)*	530-5116-01
2	Ramp Flap	535-7520-00
3	Rivet 1/8" ø X 5/32" (Qty. 2)	249-5009-00
4	E-Ring 1/4" ø	270-5002-00
5	Ramp Floor & Hinge Assembly	515-6433-00
ORDERING ABOVE (ITEM 4) ASSEMBLY PART Nº WILL INCLUDE:		
A *	Rivet 1/8" ø X 3/16" (Qty. 2) Washer 5/16" ø (Qty. 4) * Not Shown	249-5001-00 242-5017-00

Note:
The above assembly snaps in between the Top Loop Flat Rail (515-6389-00) and the Top Inner Right Loop Flat Rail (535-7460-00).

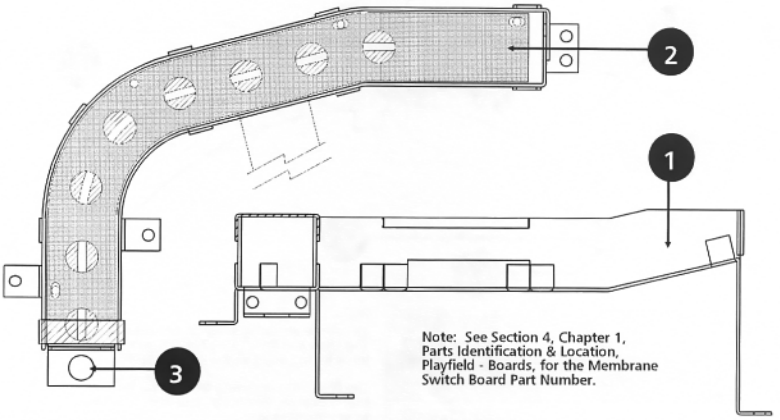
The Post Link snaps into the Link on the below Plunger Assembly. Use Item 4, E-Ring, to secure into place.

Up-Down Ramp Plunger Assembly (Operates Up-Down Metal Ramp Assy.) 500-6044-00-44



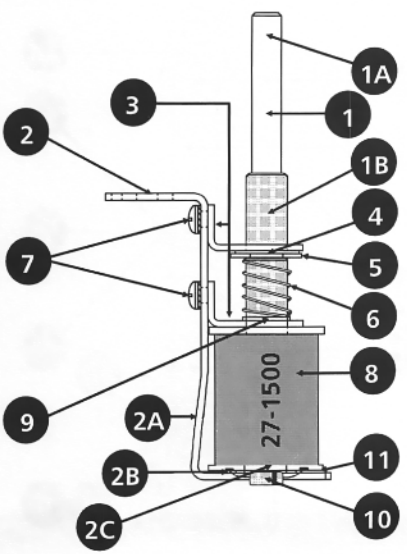
Nº	Part Name	SPI Part Nº
1	Bracket & Armature Stop Assembly	515-6435-00
ORDERING ABOVE (ITEM 1) ASSEMBLY PART Nº WILL INCLUDE:		
— — —	Mounting Bracket Armature Stop (Bottom) Shading Ring	 See Note
2	Plunger & Link Assembly	515-6461-00
ORDERING ABOVE (ITEM 2) ASSEMBLY PART Nº WILL INCLUDE:		
A B C	Link Roll Pin 1/8" ø X 5/8" Long Plunger	 See Note
3	Coil Retaining Bracket (Qty. 2)	535-5203-01
4	Nylined Bearing 7/16" ø Shaft	545-5418-00
5	Retaining Ring 7/16" ø Shaft	270-5005-00
6	HD Spring	266-5034-00
7	#8-32 X 1/4" PPHW/SEMS (Qty. 4)	232-5300-00
8	Coil 27-1500	090-5004-00
9	Coil Sleeve	545-5411-00
10	Coil Diode, 1N4004, incl. Coil Sleeve	112-5003-00

8-Ball Lock Trough Assembly (Operates with 8-Ball Lock Plunger Assy.) 500-6025-00-44


2
1
3
Note: See Section 4, Chapter 1, Parts Identification & Location, Playfield - Boards, for the Membrane Switch Board Part Number.

Nº	Part Name	SPI Part Nº	Nº	Part Name	SPI Part Nº
1	8-Ball Lock Trough	515-6424-02	3	Nyliner 5L1-FF Thomson	545-5485-00
2	Membrane Switch	181-5000-00			

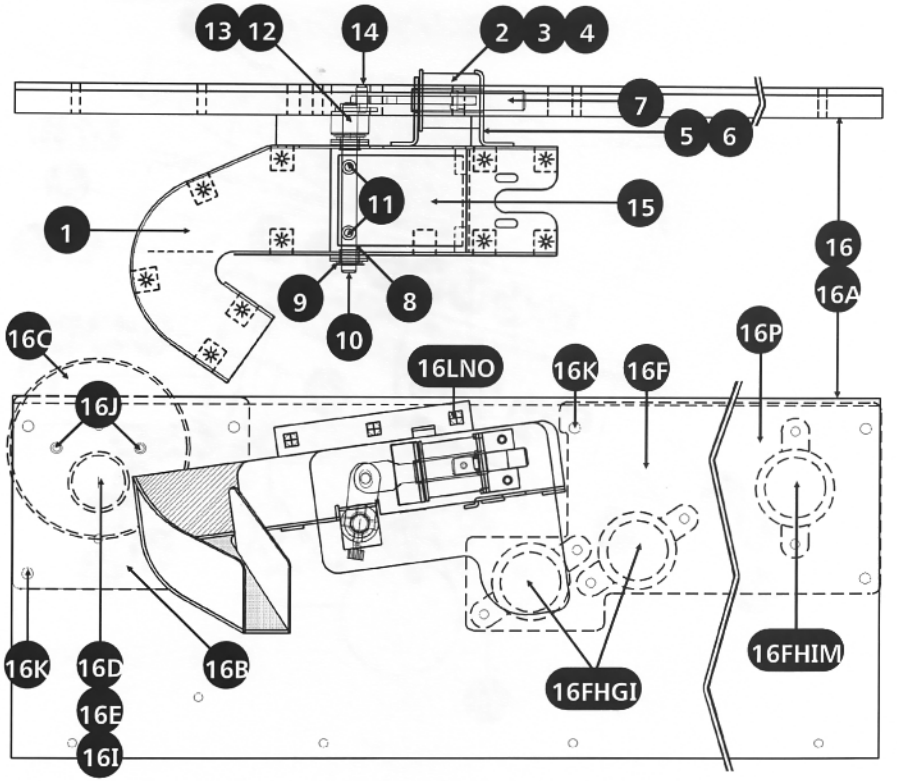
8-Ball Lock Plunger Assembly (Locks balls in the 8-Ball Lock Trough Assy.) 500-5867-01-44



Nº	Part Name	SPI Part Nº
1	Plunger Sub-Assembly	515-6119-01
A B	Metal Ball Lock Plunger Nylon Plunger	See Note
2	Mounting Bracket Sub-Assembly	515-6118-00
ORDERING ABOVE (ITEM 2) SUB-ASSEMBLY PART Nº WILL INCLUDE:		
A B C	Mounting Bracket Shading Ring Core Stop	See Note
3	Coil Bracket (Qty. 2)	535-5203-01
4	Nyliner, 7/16" ø Shaft	545-5418-00
5	Retaining Ring, 7/16" ø Shaft	270-5005-00
6	Compression Spring	266-5020-00
7	#8-32 X 1/4" PPHW/SEMS (Qty. 4)	232-5300-00
8	Coil 27-1500, incl. Coil Sleeve	090-5004-00
9	Coil Sleeve	545-5411-00
10	Coil Diode, 1N4004	112-5003-00
11	Spring Washer	269-5002-00

Note: Item names are given for reference only and cannot be ordered. For these items, the sub-assembly must be ordered.

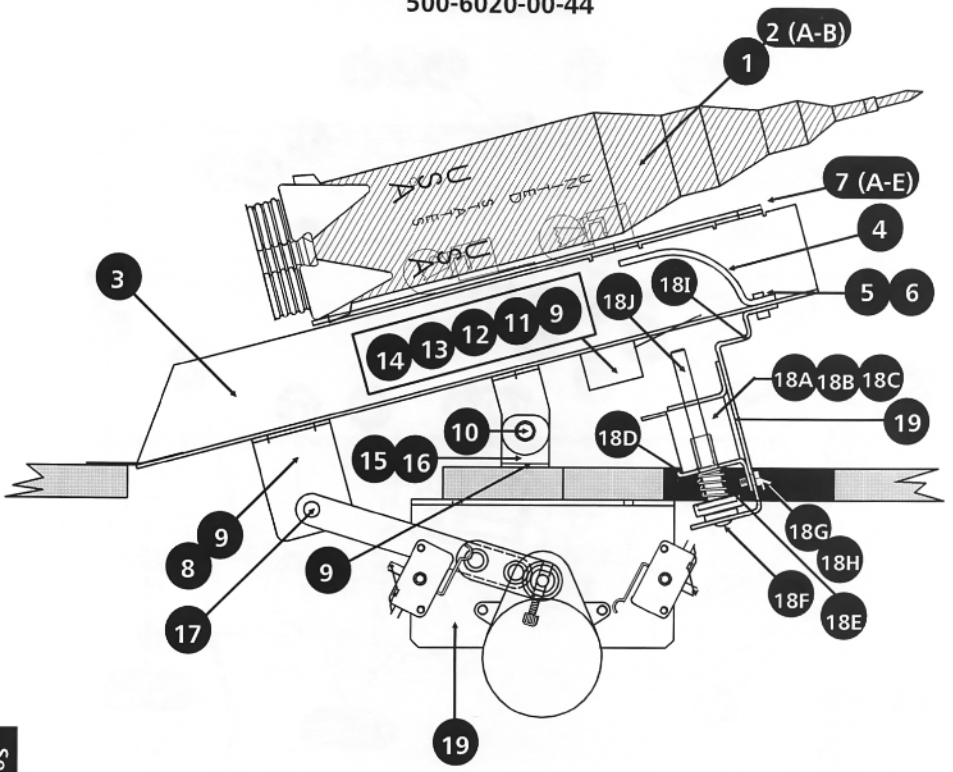
Upper Trough/Trap Door Assy. (Attached to Item 16 Back Panel Assy.) 500-6031-00-44



Nº	Part Name	SPI Part Nº
1	Trough	515-6428-00
2	Coil 28-1050, incl. Coil Sleeve	090-5046-00
3	Coil Diode, 1N4001	112-5001-00
4	Coil Sleeve	545-5500-00
5	Coil Mounting Bracket	535-7313-00
6	#6-32 X 3/16" PHMS (SEMS) (Qty. 2)	232-5209-00
7	Plunger Assembly	515-6057-00
8	Nyliner 1/4" ø 4L2-FF Thomson (Qty. 2)	545-5423-00
9	Retaining Ring 1/4" ø (Qty. 2)	270-5002-00
10	Shaft - Trap Door	530-5343-00
11	#6-32 X 3/8" FHMS (Qty. 2)	237-5871-00
12	Crank Arm Assembly	515-6184-00
ORDERING ABOVE (ITEM 12) ASSEMBLY PART Nº WILL INCLUDE:		
—	Pivot Pin	530-5330-00
—	Hub	530-5145-00
—	Crank Arm	535-7130-00
13	#8-32 SHCS	237-5897-00

Nº	Part Name	SPI Part Nº
14	Retaining Ring 3/16" ø	270-5001-00
15	Trap Door Plate	535-7283-00
16	Back Panel Assembly	500-6028-00-44
ORDERING ABOVE (ITEM 16) ASSEMBLY PART Nº WILL INCLUDE:		
A	Back Panel	525-5396-00
B	Plastic Shield Left	830-5484-22
C	Jump Bumper Cap (Red)	545-5199-02
D	2-Lug Stand-Up Short Socket	077-5001-00
E	#44 Bulb	165-5000-44
F	Mini-Mars (Red) (Qty. 3)	550-5055-02
G	Stand-Up Short Socket (Qty. 2)	077-5101-00
H	#89 Bulb	165-5000-89
I	#6 X 3/8" HWHSMS (Qty. 4)	234-5000-00
J	#5 X 1-3/4" HWH (Qty. 2)	237-5847-00
K	#6 X 1/2" PHSMS (Qty. 13)	237-5805-00
L	#10-24 Carriage Bolt (Qty. 3)	231-5002-00
M	2-Lug Straight Socket	077-5107-00
N	#10-24 KEPS Nut (Qty. 3)	240-5207-00
O	Wood Spacer	525-5409-00
P	Plastic Shield Right	830-5484-12

Rocket Ramp Assembly
500-6020-00-44



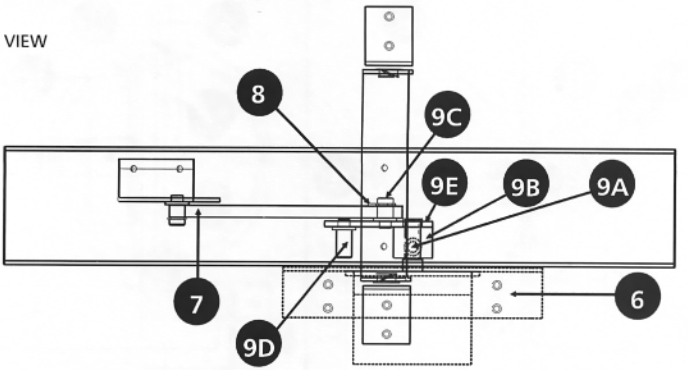
Nº	Part Name	SPI Part Nº
1	Rocket Ship	545-5649-00
2A	#8-32 x 1/2" HWH (SERR) (Qty. 4)	237-5905-00
2B	#8 Washer (Qty. 4)	242-5005-00
3	Trough	535-7499-00
4	Snubber Bracket	535-7533-00
5	#8-32 X 5/8" THR. Form (Qty. 2)	237-5951-00
6	#8-32 Stop Nut (Qty. 2)	240-5102-00
7	Butyrate Assembly -38	515-6468-38
ORDERING ABOVE (ITEM 7) ASSEMBLY PART Nº WILL INCLUDE:		
A	Plastic Shield	830-5484-38
B	Laydown Standard Socket (Qty. 2)	077-5100-00
C	#89 Bulb (Qty. 2)	169-5000-89
D	Rivet 1/8" ø X 3/16" (Qty. 2)	249-5001-00
E	Washer (Qty. 2)	246-5000-00
8	Bracket Assembly	515-6415-00
9	Rivet 1/8" ø X 3/16" (Qty. 5)	249-5001-00
10	Nyliner (Qty. 2)	545-5423-00
11	Micro Switch (Loop Type)	180-5116-00

Nº	Part Name	SPI Part Nº
12	Micro Switch Bracket	535-7532-00
13	#2-56 X 3/8" THR. Form (Qty. 2)	237-5938-00
14	Switch Diode, 1N4001	112-5001-00
15	Stationary Pivot Bracket Assy. (Qty. 2)	515-6417-00
16	Pivot Bracket	535-7501-00
17	Retaining Ring 1/4" ø	270-5002-00
18	Mini-VUK Assembly	515-6441-00
ORDERING ABOVE (ITEM 18) ASSEMBLY PART Nº WILL INCLUDE:		
A	Coil 28-1050, incl. Coil Sleeve	090-5046-00
B	Coil Diode, 1N4001	112-5001-00
C	Coil Sleeve	545-5500-00
D	Coil Mounting Bracket	535-7534-00
E	Spring	266-5050-00
F	Rubber Bumper (Grommet)	545-5105-00
G	#8-32 X 3/8" HWHMS TF (Qty. 2)	237-5967-00
H	Washer (Qty. 2)	242-5005-00
I	Coil Bracket Weld Assembly	515-6443-00
J	Plunger Assembly	515-6442-00
19 *	Motor, Bracket & CAM Assembly	515-6414-00

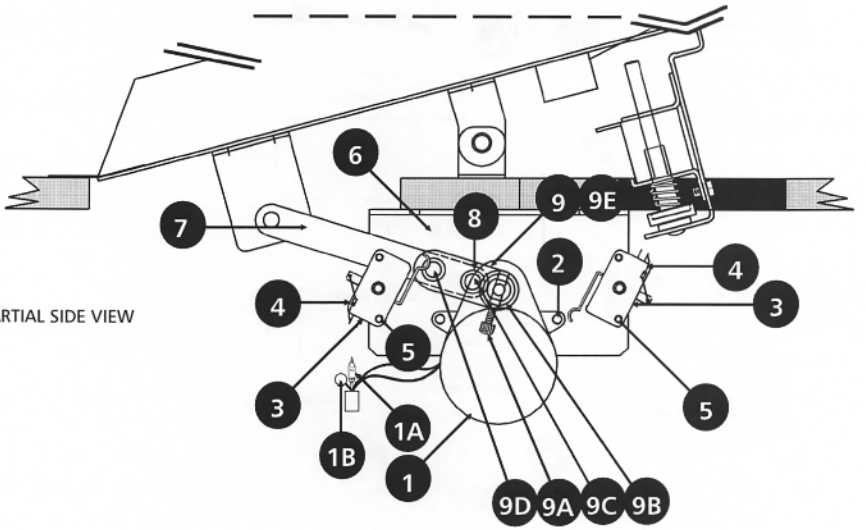
* See next page for detail of item 19 with a breakdown of parts.

Motor, Bracket & Cam Sub-Assembly (Detail from Rocket Ramp Assy.)
515-6414-00

PARTIAL TOP VIEW



PARTIAL SIDE VIEW

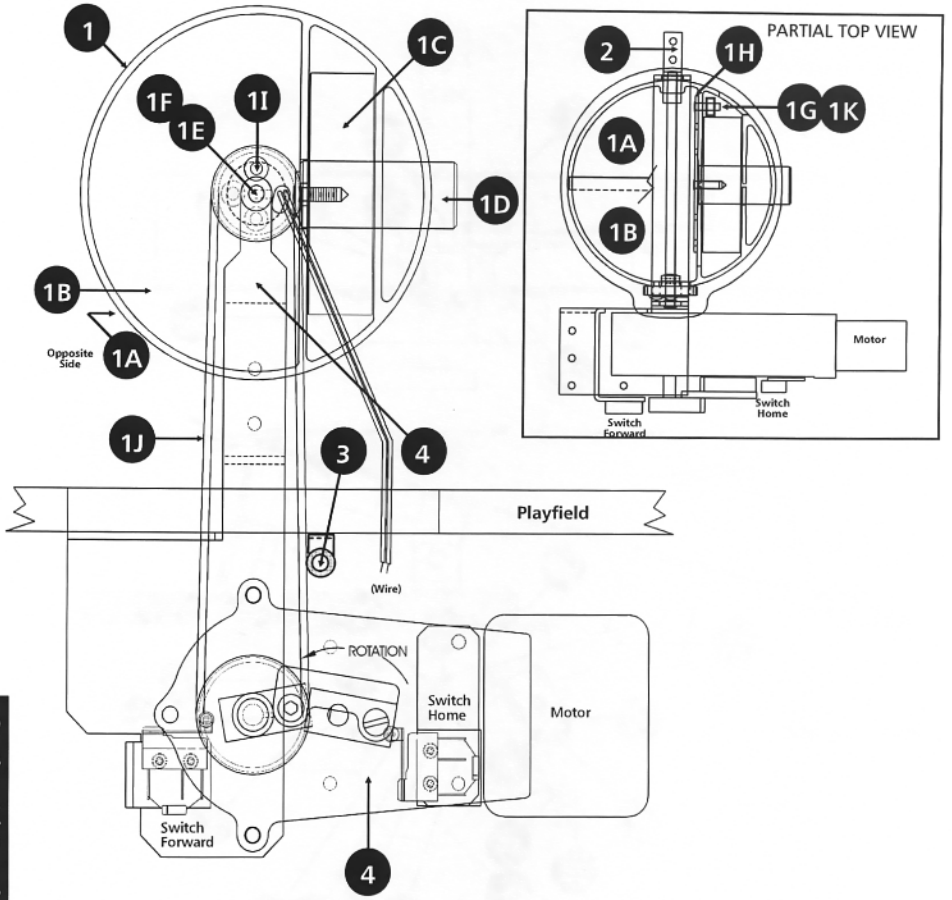


Nº	Part Name	SPI Part Nº
1	Motor Assembly	515-6383-00
A †	Neon Bulb	165-5021-00
B †	Capacitor .1 MFD 500V Disc	130-5000-00
2	#6-32 X 1/4" PHMS SEMS (Qty. 2)	232-5200-00
3	Micro Switch (Qty. 2)	180-5052-00
4	Switch Diode, 1N4001 (Qty. 2)	112-5001-00
5	#4-40 X 5/8" PHMS (SEMS) (Qty. 4)	237-5832-00
6	Motor Bracket	535-7500-00

Nº	Part Name	SPI Part Nº
7	Link	535-7504-00
8	Retaining Ring 1/4" ø	270-5002-00
9	CAM Link Assembly (Rocket)	515-6448-00
ORDERING ABOVE (ITEM 9) ASSEMBLY PART Nº WILL INCLUDE:		
A	Socket Head Cap Screw	237-5897-00
B	Hub	530-5364-00
C	Shoulder Pin (Center)	530-5366-00
D	Shoulder Pin (Opposite Hub)	530-5390-00
E	Cam Link (Rocket)	535-7529-00

† **Items 1A**, Neon Bulb, & **1B**, Capacitor, ***are included*** with **Item 1**, Motor Assembly. Items **1A / 1B** can be ordered separately, if required. (*Operation Note*: **The bulb** is used for spike suppression and the **capacitor** is used to eliminate line noise.)

Moon Unit Assembly †
500-6021-00-44



Nº	Part Name	SPI Part Nº
1	Moon Sub-Assembly	515-6408-00
ORDERING ABOVE (ITEM 1) ASSEMBLY PART Nº WILL INCLUDE:		
A	Moon Half (Left)	545-5642-00
B	Moon Half (Right)	545-5641-00
C	Magnet Coil	090-5042-01
D	Magnet Core	530-5372-00
E	Shaft & Gear Assembly	515-6406-00
F	Retaining Ring 3/16" ø (Qty. 3)	270-5001-00
G	#6-32 Stop Nut	240-5005-00
H	Fastening Plate	515-6404-00
I	#6 X 1/2" PHSMS (Truss) (Qty. 3)	237-5809-00
J	Drive Belt	545-5643-00
K	#6 Washer	242-5001-00

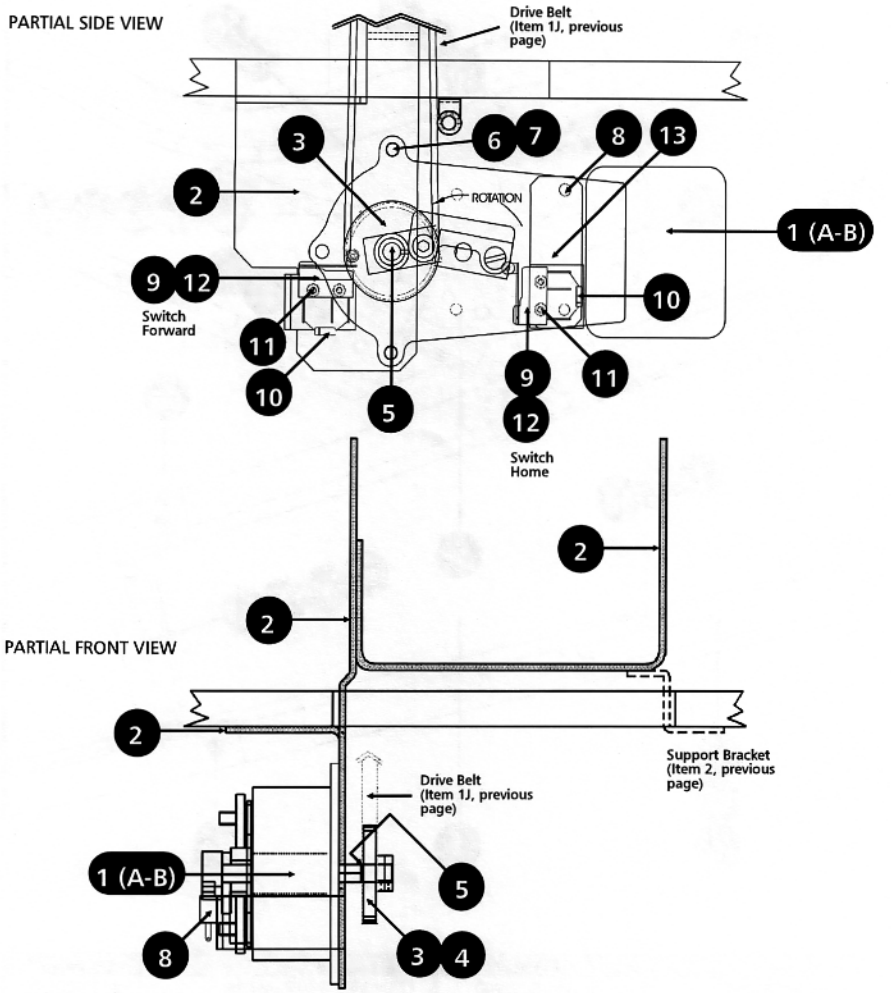
Nº	Part Name	SPI Part Nº
2	Support Bracket	535-7538-00
3 †	Roller Assembly †	515-6451-00
ORDERING ABOVE (ITEM 3) ASSEMBLY PART Nº WILL INCLUDE:		
—	Roller Assembly (Staking)	515-6452-00
—	Nylon Roller (Qty. 2)	530-5083-00
—	Retaining Ring 1/4" ø	270-5002-00

† Item 3, Roller Assembly, is not included with the Moon Unit Assembly, 500-6021-00-44. It must be ordered in addition if required. This roller assembly is located under the playfield (see diagram above) and help keeps the drive belt (Item 1J) taught.

4	Motor, Bracket & Cam Sub-Assembly	515-6407-00

See next page for detail of item 4 with a breakdown of parts.

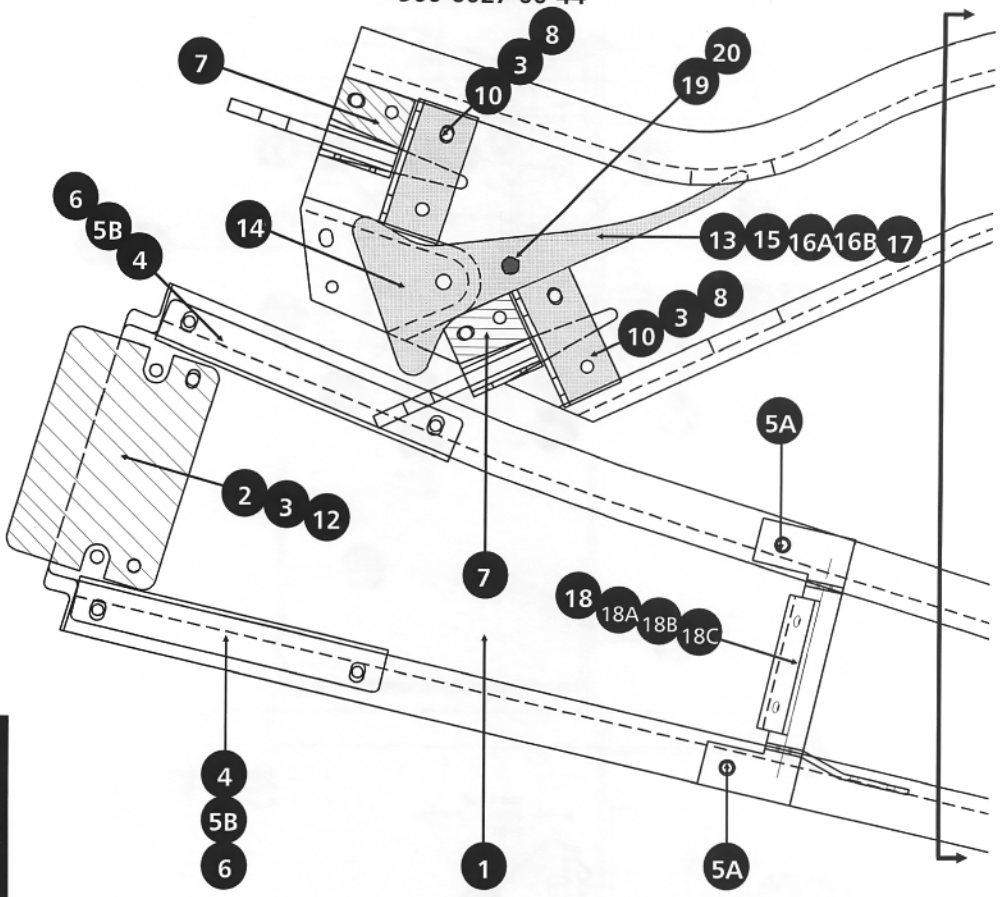
Motor, Bracket & Cam Sub-Assembly (Detail from Moon Unit Assy.) 515-6407-00



№	Part Name	SPI Part №	№	Part Name	SPI Part №
1	Motor Assembly	515-6487-00	7	#8-32 Hex Nut (Qty. 2)	240-5104-00
A †	Neon Bulb (Not Shown)	165-5021-00	8	#8-32 X 1/4" PHMS PAN	237-5974-00
B †	Capacitor .1 MFD 500V Disc (Not Shown)	130-5000-00	9	Micro Switch (Roller Actuator) (Qty. 2)	180-5119-00
2	Motor & Support Bracket Weld Assy.	515-6447-00	10	Switch Diode, 1N4001 (Qty. 2)	112-5001-00
3	Gear	530-5374-02	11	#2-56 X 3/8" TF (Qty. 4)	237-5938-00
4	#6-32 X 3/8" SHCS	237-5944-00	12	Fiche Paper (Qty. 2)	545-5431-00
5	Retaining Ring 1/4" ø	270-5002-00	13	Home Switch Plate Bracket	535-7477-00
6	#8-32 X 5/8" HWHMS (Qty. 2)	237-5907-00			

† **Items 1A, Neon Bulb, & 1B, Capacitor, *are included* with Item 1, Motor Assembly. Items 1A / 1B can be ordered separately, if required. (*Operation Note*: The bulb is used for spike suppression and the capacitor is used to eliminate line noise.)**

Plastic Ramp Assembly
500-6027-00-44

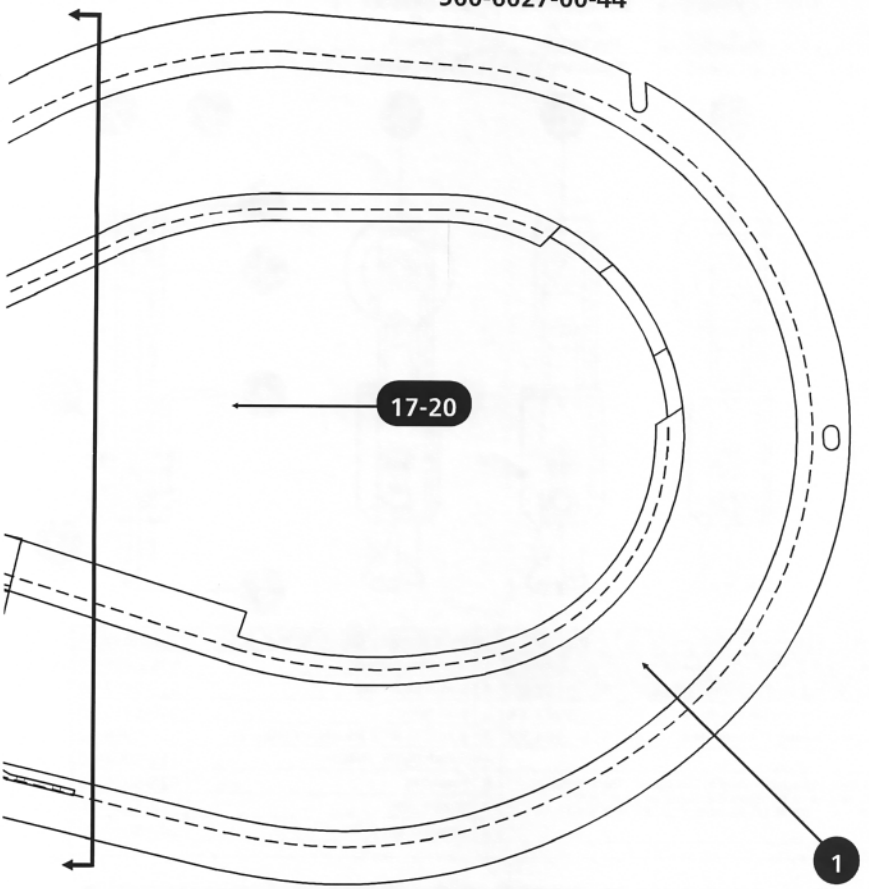


Nº	Part Name	SPI Part Nº
1	Plastic Ramp Assembly	545-5639-00
2	Ramp Flap	535-7208-00
3	Washer (Qty. 6)	242-5017-00
4	Entrance Protect Plate Lt./Rt. (Qty. 2)	535-6707-01
5A	#6 X 1/2" Truss (Qty. 2)	237-5809-00
5B	#6 x 3/8" HWH (Qty. 4)	234-5000-00
6	Double Sided Tape (2 pieces)	626-5027-00
7	Exit Switch Sub-Assembly (Qty. 2)	515-6469-00
ORDERING ABOVE (ITEM 7) ASSEMBLY PART Nº WILL INCLUDE:		
—	Micro Switch	180-5093-00
—	#2-56 HWH TDH FORM (Qty. 2)	237-5938-00
—	Switch Bracket	535-7319-04

Nº	Part Name	SPI Part Nº
8	Rivet 1/8" ø X 3/16" (Qty. 10)	249-5001-00
9	Exit Switches Cable Harness	036-5380-06
10	Exit Ramp Bracket (Qty. 2)	535-5291-00
11	Entrance Gate Cable Harness (Not Shown)	036-5380-03
12	Ramp Flap Rivet 3/8" ø (Qty. 2)	249-5009-00
13	Diverter Plate	535-7511-00
14	Base Plate Assembly	515-6427-00
15	Spring	265-5041-00
16A	Nyloc Stop Nut 8-32	240-5102-00
16B	#8 Washer	242-5005-00

Items continued on the next page.

Plastic Ramp Assembly Continued
500-6027-00-44



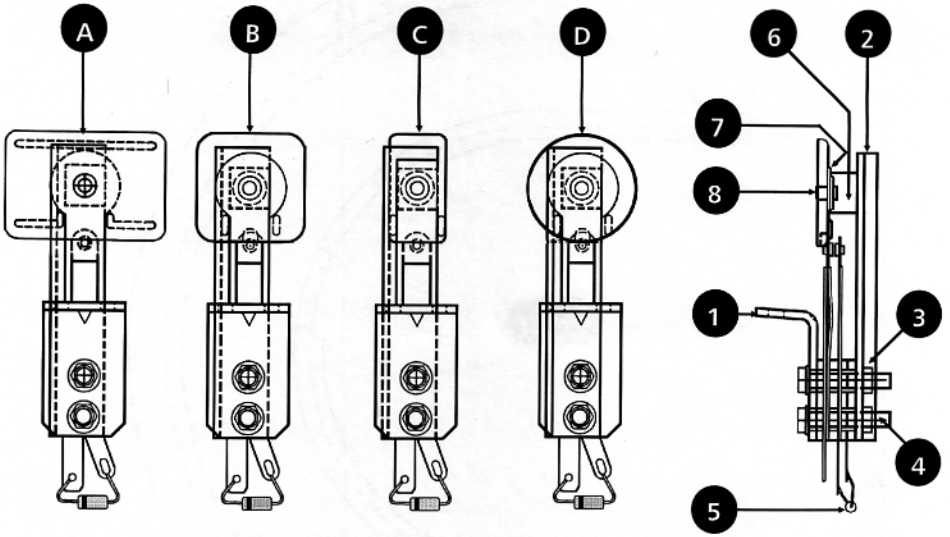
Items continued from the previous page.

Nº	Part Name	SPI Part Nº
17	Washer Nylon 8-32	242-5040-00
18	Entrance Gate Assembly	515-6444-00
	ORDERING ABOVE (ITEM 18) ASSEMBLY PART Nº WILL INCLUDE:	
A	Ramp Sign Bracket Sub-Assembly	515-6359-00
	Ordering above (Item 18A) Sub-Assembly Part Nº will include:	
	Dual Entrance Rollunder Wire Form	535-7304-00
	Dual Ramp Right Entry Gate	535-7303-00
	Micro Switch	180-5090-00
	Switch Diode, 1N4001	112-5001-00
	#2-56 X 1/2" HWH (Qty. 2)	237-5937-00
B	Plastic Shield Sub-Assembly	515-6468-17
	Ordering above (Item 18B) Sub-Assembly Part Nº will include:	
	Plastic Shield	830-5484-17
	Laydown Wedge Socket (Qty. 2)	077-5026-00
	#555 Wedge Base Bulb (Qty. 2)	165-5002-00
	Rivet 1/8" ø X 3/16" (Qty. 2)	249-5001-00
	Washer (Qty. 2)	246-5000-00
	Rubber Lite Cover-Red	545-5014-02
	Rubber Lite Cover-Yellow	545-5014-06
C	#6 X 3/8" HWH (Qty. 2)	234-5000-00
19	1-1/2" Hex Spacer	254-5008-09
20	#6-32 X 3/8" PPH	232-5201-00

Continued in the next column.

Stand-Up Target Assemblies: †

500-5321-XX 1" X 1-1/2" Rectangle	500-5232-XX 1" Square	500-5857-XX Narrow Rectangle	500-5835-XX 1" Round	All
(Front View)	(Front View)	(Front View)	(Front View)	(Side View)



Nº	Switch & Target Name	QTY.	Part Nº
A	Sw. & Target Assy. 1" X 1½" Rect. (Flat)	0	515-6027-XX
B	Switch & Target Assembly 1" Square (Flat)	0	515-5162-XX
C	Sw. & Target Assy. Narrow Rectangle (Flat)	9	515-5967-XX
D	Switch & Target Assembly 1" Round (Flat)	4	515-5966-XX

† Items with a Ø quantity are not used in this game. The following are the color breakdowns for items C & D (replace the "-XX"):
C: X1 "-04, GRN", X1 "-05, BLU", X3 "-06, YEL", X4 "-08, WHT"
D: X4 "-02, RED".

Nº	Part Names for A, B, C & D	Part Nº
1	Mounting Bracket	535-6896-00
2	Switch Back Plate	535-6452-00
3	6-32 Nyloc	240-5010-00
4	6-32 X ¾ HWH Ser. (Type C) (Qty. 2)	237-5958-00
5	Switch Diode, 1N4001	112-5001-00
6	Foam Pad	626-5029-00
7	Washer 5/16"	242-5017-00
8	Rivet 1/8" ø X 3/16"	249-5001-00

Plastic Part Color Chart

(As applicable for all parts which are available in various colors.)
The "-XX" should be replaced with the following 2-Digit Number for the color desired:

-01:	Clear	-06:	Yellow	-11:	Flourescent Green
-02:	Red	-07:	Orange	-12:	Flourescent Blue
-03:	Amber	-08:	White	-13:	Teal Green
-04:	Green	-09:	Purple	-14:	Gray
-05:	Blue	-10:	Flourescent Orange	-15:	Luminescent

Schematics & Troubleshooting

Section 5
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  - I/O Power Driver Board Schematic (Sheet 3 of 5) 113
  - I/O Power Driver Board Schematic (Sheet 4 of 5) 114
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  - CPU/Sound Board Theory of Operation 118
  - CPU/Sound Board Schematic (Sheet 1 of 3) 119
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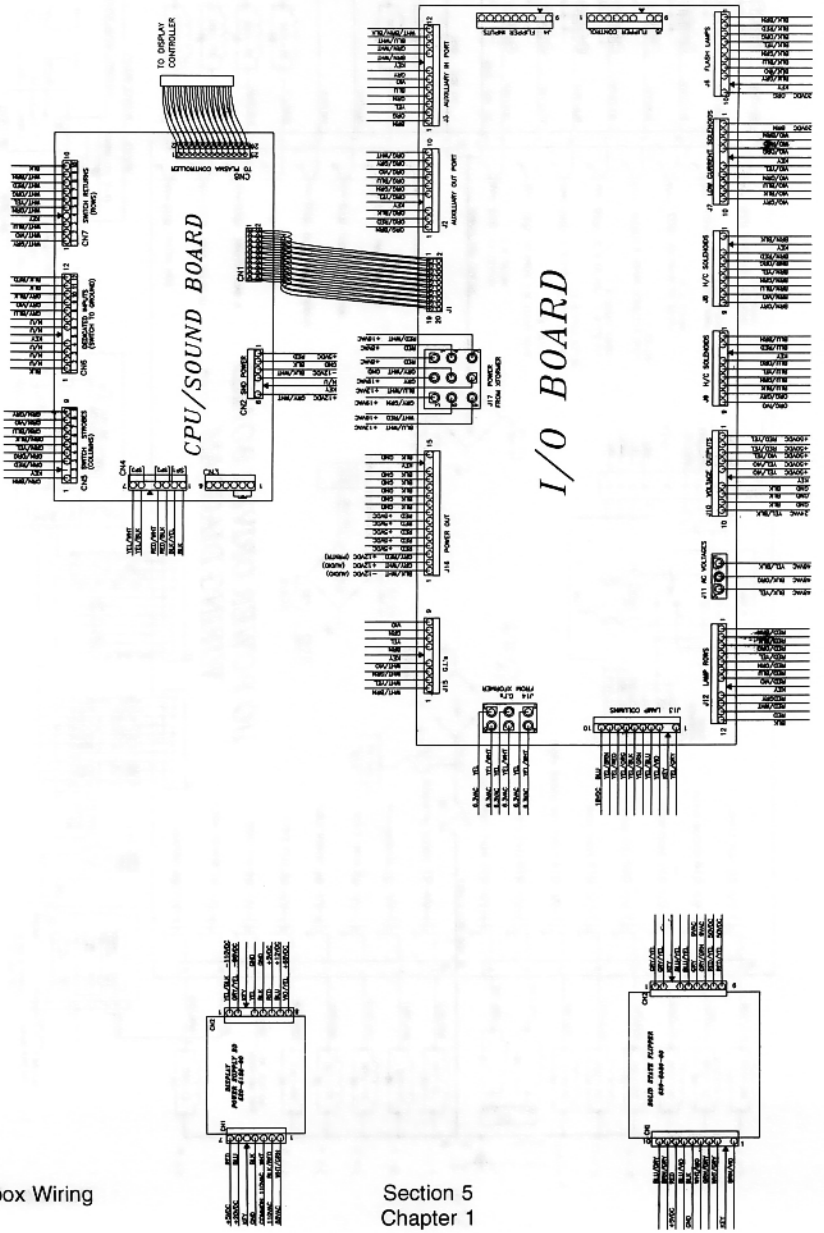
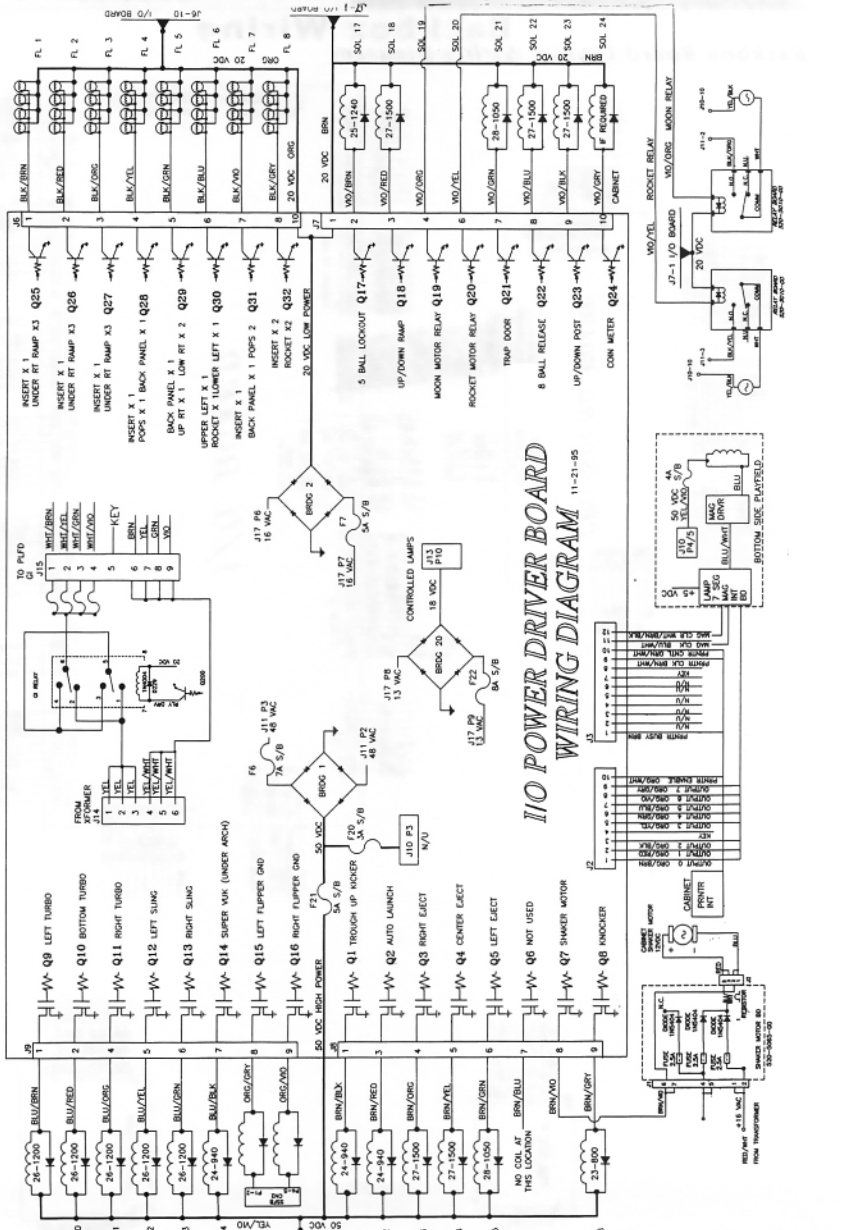
  - CPU/Sound Board Parts 123

Your Notes

Backbox Wiring

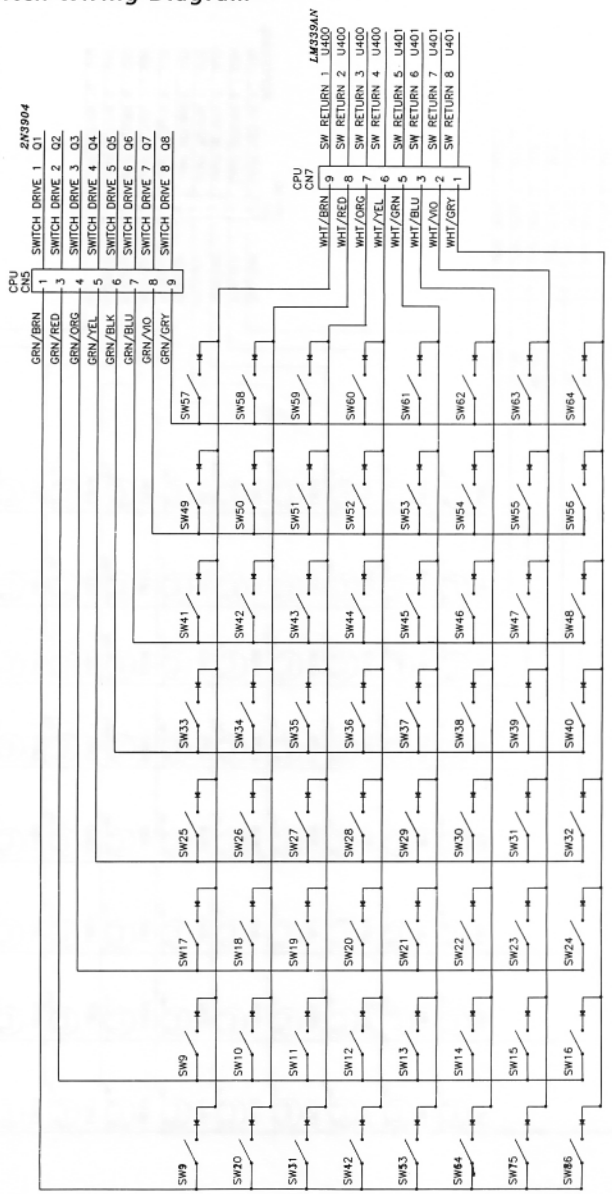
Backbox Board Layout Wiring Diagram

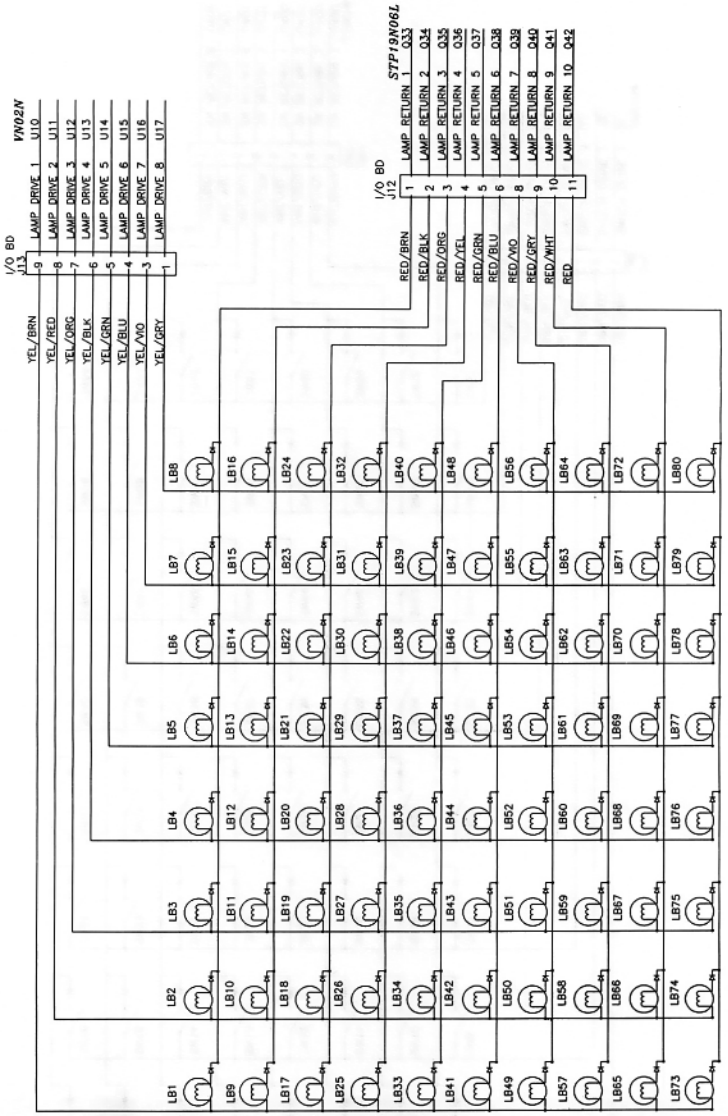


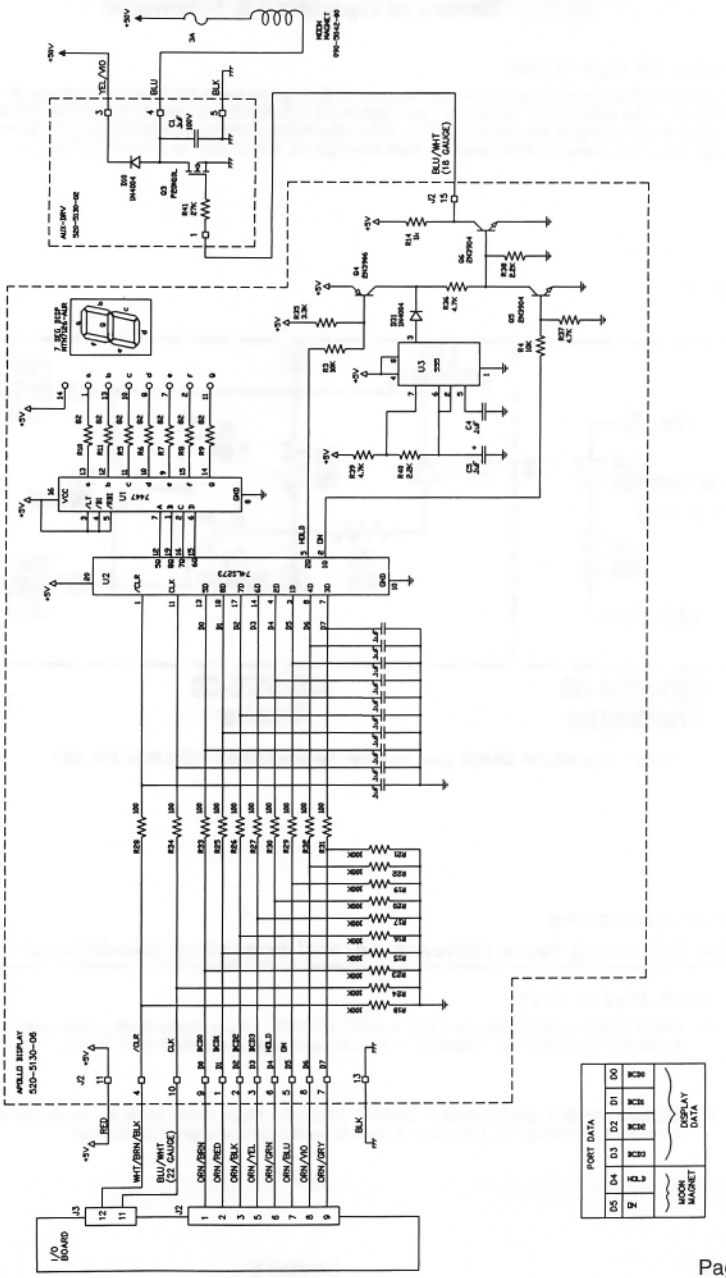

I/O POWER DRIVER BOARD
WIRING DIAGRAM
11-21-95
TO PLFD
J15
KEY
FROM XFORMER
J14
J11 P3
46 VAC
J11 P2
48 VAC
BRDG 1
BRDG 2
BRDG 20
F6
7A S/B
F7
5A S/B
F20
5A S/B
F21
5A S/B
F22
8A S/B
J17 P6
16 VAC
J17 P7
16 VAC
J17 P8
13 VAC
J17 P9
13 VAC
J10 P3
N/U
J15 P10
CONTROLLED LAMPS
18 VDC
50 VDC HIGH POWER
20 VDC LOW POWER
J1
J2
J3
J5
J6
J7
J8
J9
J7-1 I/O BOARD
ROCKET RELAY
MOON RELAY
BOTTOM SIDE PLAYFIELD
CABINET PRINTR INT
INSERT X 1 UNDER RT RAMP X3 Q25
INSERT X 1 UNDER RT RAMP X3 Q26
INSERT X 1 UNDER RT RAMP X3 Q27
INSERT X 1 POPS X 1 BACK PANEL X 1 Q28
BACK PANEL X 1 UP RT X 1 LOW RT X 2 Q29
UPPER LEFT X 1 ROCKET X 1 LOWER LEFT X 1 Q30
INSERT X 1 BACK PANEL X 1 POPS 2 Q31
INSERT X 2 ROCKET X2 Q32
5 BALL LOCKOUT Q17
UP/DOWN RAMP Q18
MOON MOTOR RELAY Q19
ROCKET MOTOR RELAY Q20
TRAP DOOR Q21
8 BALL RELEASE Q22
UP/DOWN POST Q23
COIN METER Q24
Q9 LEFT TURBO
Q10 BOTTOM TURBO
Q11 RIGHT TURBO
Q12 LEFT SLING
Q13 RIGHT SLING
Q14 SUPER VUK (UNDER ARCH)
Q15 LEFT FLIPPER GND
Q16 RIGHT FLIPPER GND
Q1 TROUGH UP KICKER
Q2 AUTO LAUNCH
Q3 RIGHT EJECT
Q4 CENTER EJECT
Q5 LEFT EJECT
Q6 NOT USED
Q7 SHAKER MOTOR
Q8 KNOCKER
NO COIL AT THIS LOCATION
SHAKER MOTOR
CABINET
ROCKET
CABINET MOTOR 12VDC
SHAKER MOTOR BD
RED/WHT @ 115 VAC FROM TRANSFORMER

Playfield Wiring

Playfield Switch Wiring Diagram




I/O BD
J13
VN02N
LAMP DRIVE 1 U10
LAMP DRIVE 2 U11
LAMP DRIVE 3 U12
LAMP DRIVE 4 U13
LAMP DRIVE 5 U14
LAMP DRIVE 6 U15
LAMP DRIVE 7 U16
LAMP DRIVE 8 U17
YEL/BRN
YEL/RED
YEL/ORG
YEL/BLK
YEL/GRN
YEL/BLU
YEL/VIO
YEL/GRY
I/O BD
J12
STP19N06L
LAMP RETURN 1 Q33
LAMP RETURN 2 Q34
LAMP RETURN 3 Q35
LAMP RETURN 4 Q36
LAMP RETURN 5 Q37
LAMP RETURN 6 Q38
LAMP RETURN 7 Q39
LAMP RETURN 8 Q40
LAMP RETURN 9 Q41
LAMP RETURN 10 Q42
RED/BRN
RED/BLK
RED/ORG
RED/YEL
RED/GRN
RED/BLU
RED/VIO
RED/GRY
RED/WHT
RED
LB1 LB2 LB3 LB4 LB5 LB6 LB7 LB8
LB9 LB10 LB11 LB12 LB13 LB14 LB15 LB16
LB17 LB18 LB19 LB20 LB21 LB22 LB23 LB24
LB25 LB26 LB27 LB28 LB29 LB30 LB31 LB32
LB33 LB34 LB35 LB36 LB37 LB38 LB39 LB40
LB41 LB42 LB43 LB44 LB45 LB46 LB47 LB48
LB49 LB50 LB51 LB52 LB53 LB54 LB55 LB56
LB57 LB58 LB59 LB60 LB61 LB62 LB63 LB64
LB65 LB66 LB67 LB68 LB69 LB70 LB71 LB72
LB73 LB74 LB75 LB76 LB77 LB78 LB79 LB80

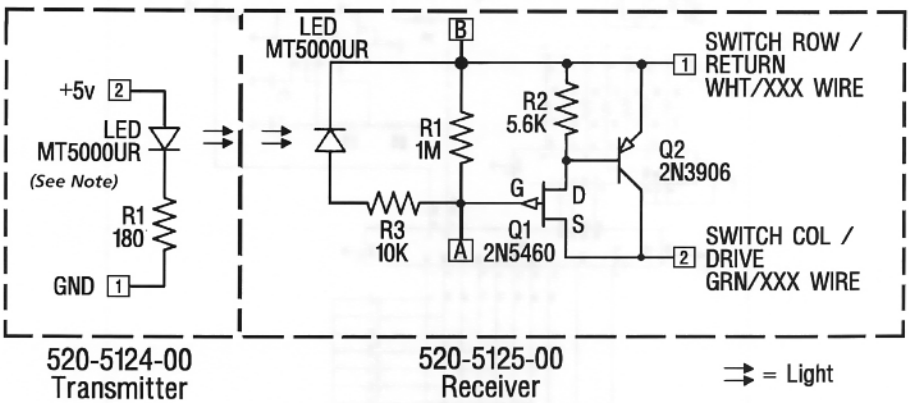

APOLLO DISPLAY
520-5130-06
I/O BOARD
WHT/BRN/BLK
BLU/WHT (22 GAUGE)
ORN/BRN
ORN/RED
ORN/BLK
ORN/YEL
ORN/GRN
ORN/BLU
ORN/VIO
ORN/GRY
BLU/WHT (18 GAUGE)
PORT DATA
D0 BCD0
D1 BCD1
D2 BCD2
D3 BCD3
D4 HOLD
D5 DP
DISPLAY DATA
MOON MAGNET

Trough Up-Kicker OPTO
Theory of Operation & Schematic

Theory of Operation

As light from the Transmitter falls on the Receiver LED, it generates a Positive Bias Voltage (0.7v to 1.5v) which is applied to the gate of **Q1**, turning **Q1** off. When **Q1** is held off, no current flows through **Q2**'s Base, the transistor is off acting as an *OPEN SWITCH*. When the light is interrupted (*BLOCKED*) **R1** bleeds the gate voltage off of **Q1** allowing it to conduct, switching **Q2** on, which acts as a *CLOSED SWITCH*.

Fig. 1



Note: The RADIO SHACK part number for the LED MT5000UR is 276-087.

Troubleshooting

(The following tests indicate normal operating conditions)

1. Volt Meter Test:

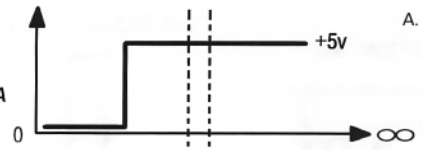
A. **OPEN OPTO** (Light Falling on LED) = *SWITCH OPEN*. Place meter leads across points **A** and **B** (Refer to Schematic Drawing Fig. 1 above). It should read approximately 0.8 - 1.2v DC.

B. **CLOSED OPTO** (Light Blocked) = *SWITCH CLOSED*. Place meter leads across points **A** and **B** (Refer to Schematic Drawing Fig. 1 above). It should read approximately 0.0 - 0.1v DC.

Troubleshooting Continued

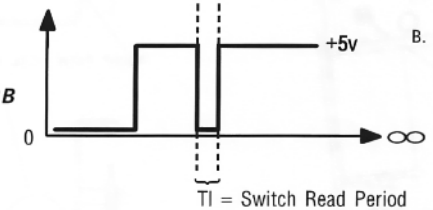
2. Oscilloscope Test:

Fig. 2A



A. **OPEN OPTO** (Light Falling on LED) = *SWITCH OPEN*. Place Scope lead at **Pin-1** of OPTO Rec. Bd. with Scope Grounded. (See Fig. 1). The Scope should display a **STEADY +5v** as shown in Fig. 2A, Wave Form Diagram.

Fig. 2B

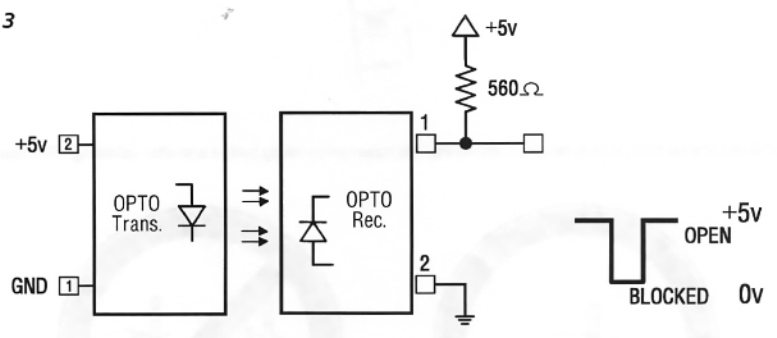


B. **CLOSED OPTO** (Light Blocked) = *SWITCH CLOSED*. Place Scope lead at **Pin-1** of OPTO Rec. Bd. with Scope Grounded. (See Fig. 1). The Scope should display a **PULSE STREAM** indicating **Q2** has switched "On" as shown in Fig. 2B, Wave Form Diagram. This is your Switch Drive Pulse.

3. Bench Test (See Fig. 3 Below):

Disconnect the OPTO Transmitter / Receiver Board from the circuit. Connect one side of a 560W Pull-up Resistor to **Pin-1** of the OPTO Receiver Bd. and the other side of the resistor to a 5v DC source. Connect **Pin-2** to Ground. Connect a +5v DC source to **Pin-1** of the Transmitter and GND to **Pin-2**. Align with the Receiver OPTO approximately 3" distance. Using your Volt-Meter or an Oscilloscope, monitor **Pin-1** while *BLOCKING* and *UN-BLOCKING* the ***BEAM*** from the Transmitter. The output will be approximately +5v DC when the ***BEAM*** is *not BLOCKED* and approximately 0 volts when the ***BEAM*** is *BLOCKED*.

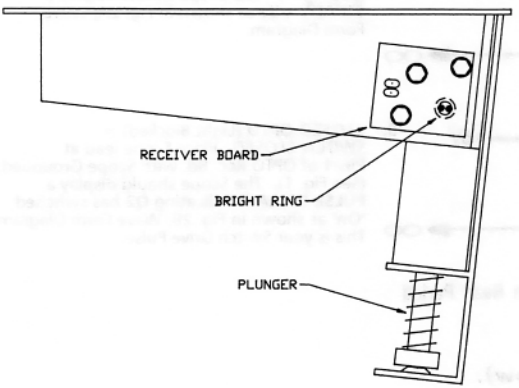
Fig. 3



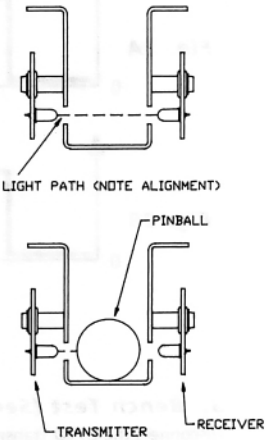
Single Trough OPTO Alignment / Test

When a working OPTO is installed and connected in a game, the transmitter should light when the power is switched on. With the playfield in Service Position #1 (playfield pulled forward resting on the playfield support brackets) and the game on, the light should show up as a "*RED RING*" through the back of the Receiver Board around the Receiver LED. With the game in Switch Test Mode, lifting the Trough Plunger with a fingertip should block the Beam and cause the Switch Position to trigger.

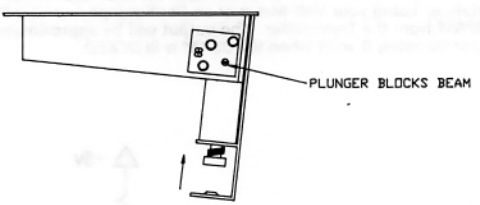
VIEW FACING TROUGH
(PLAYFIELD IN SERVICE POSITION #1)



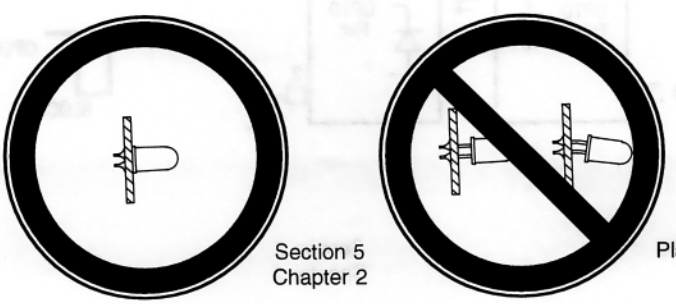
SECTIONAL VIEW FROM RIGHT



LIFT PLUNGER TO CHECK SWITCH AS SHOWN

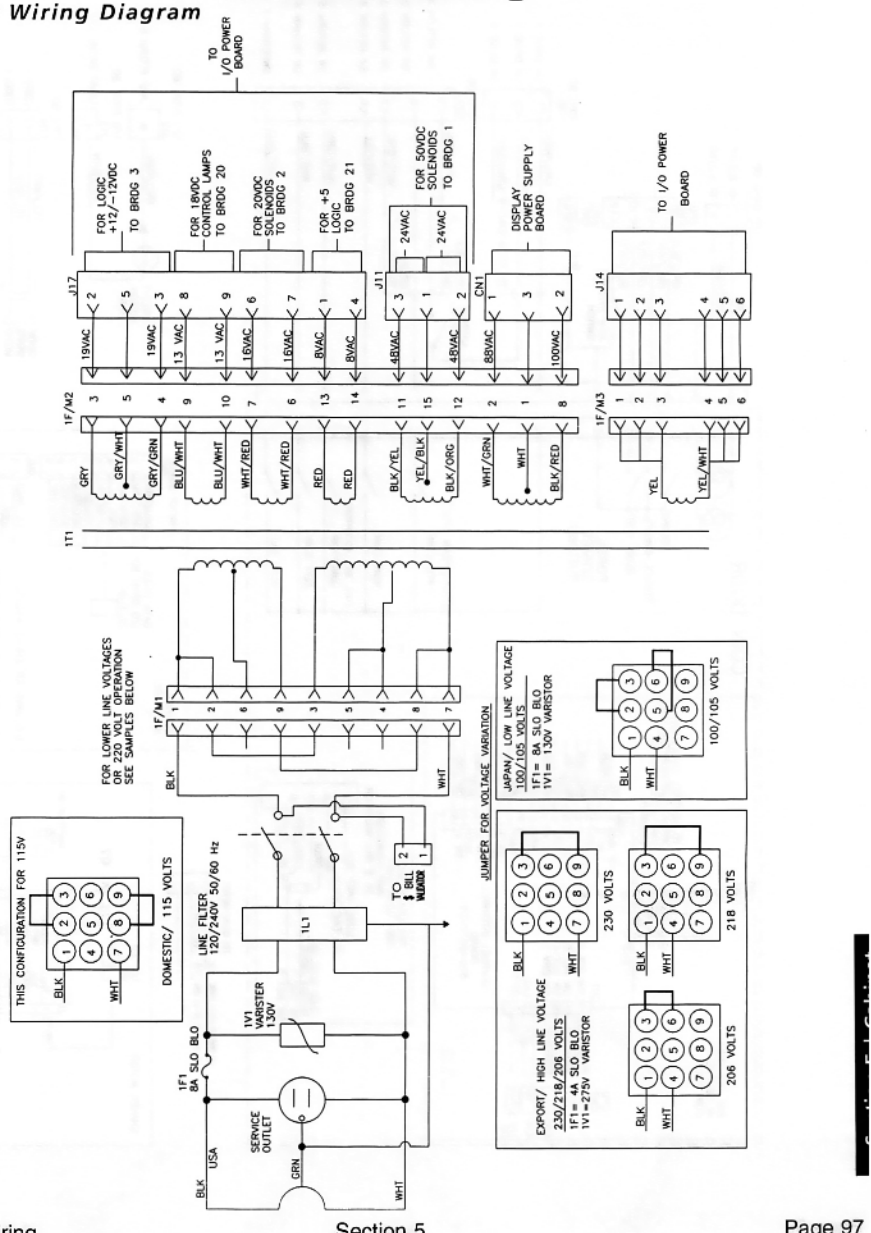


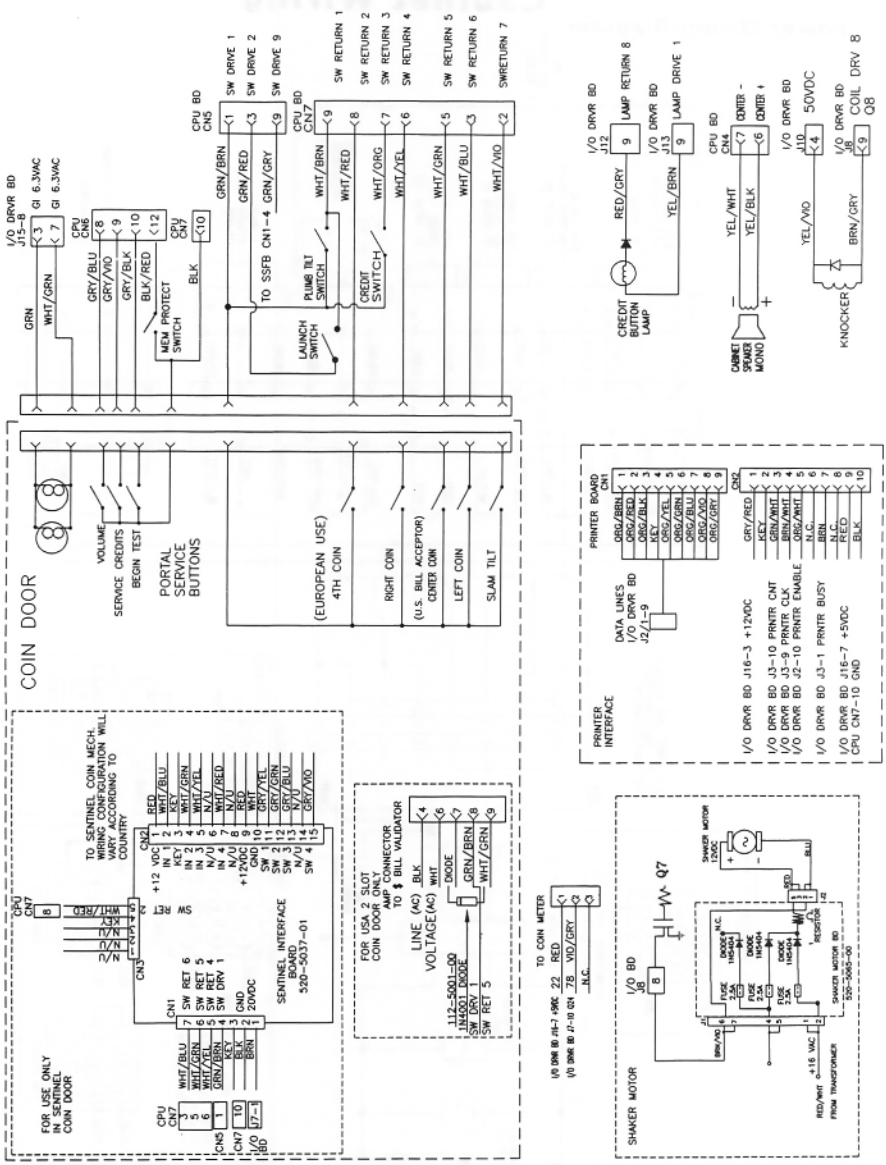
NOTE: If replacement of L.E.D. is required, insure that it is mounted correctly before and after soldering. See example below:



Cabinet Wiring

Power Wiring Diagram




COIN DOOR
VOLUME
SERVICE CREDITS
BEGIN TEST
PORTAL SERVICE BUTTONS
(EUROPEAN USE) 4TH COIN
RIGHT COIN
(U.S. BILL ACCEPTOR) CENTER COIN
LEFT COIN
SLAM TILT
I/O DRVR BD J15-8
GRN
WHT/GRN
GI 6.3VAC
GI 6.3VAC
CPU CN6
GRY/BLU
GRY/VIO
GRY/BLK
BLK/RED
MEM PROTECT SWITCH
BLK
CPU CN7
CPU BD CN5
GRN/BRN
GRN/RED
GRN/GRY
TO SSFB CN1-4
PLUMB TILT SWITCH
LAUNCH SWITCH
CREDIT SWITCH
CPU BD CN7
WHT/BRN
WHT/RED
WHT/ORG
WHT/YEL
WHT/GRN
WHT/BLU
WHT/VIO
SW DRIVE 1
SW DRIVE 2
SW DRIVE 9
SW RETURN 1
SW RETURN 2
SW RETURN 3
SW RETURN 4
SW RETURN 5
SW RETURN 6
SW RETURN 7
I/O DRVR BD J12
LAMP RETURN 8
RED/GRY
CREDIT BUTTON LAMP
I/O DRVR BD J13
LAMP DRIVE 1
YEL/BRN
CPU BD CN4
CONTR -
CONTR +
YEL/WHT
YEL/BLK
CABINET SPEAKER MONO
I/O DRVR BD J10
5.0VDC
YEL/VIO
I/O DRVR BD J8
COIL DRV 8
Q8
BRN/GRY
KNOCKER
PRINTER INTERFACE
PRINTER BOARD CN1
DATA LINES I/O DRVR BD J2/1-9
ORG/BRN
ORG/RED
ORG/BLK
ORG/YEL
ORG/GRN
ORG/BLU
ORG/VIO
ORG/GRY
CN2
I/O DRVR BD J16-3 +12VDC
I/O DRVR BD J3-10 PRNTR CNT
I/O DRVR BD J3-9 PRNTR CLK
I/O DRVR BD J2-10 PRNTR ENABLE
I/O DRVR BD J3-1 PRNTR BUSY
I/O DRVR BD J16-7 +5VDC
CPU CN7-10 GND
GRY/RED
KEY
GRN/WHT
BRN/WHT
ORG/WHT
N.C.
N.C.
N.C.
RED
BLK
FOR USE ONLY IN SENTINEL COIN DOOR
CPU CN7
CN3
CN1
WHT/BLU
WHT/GRN
WHT/YEL
GRN/BRN
SW RET 6
SW RET 5
SW RET 4
SW DRV 1
GND
20VDC
SENTINEL INTERFACE BOARD 520-5037-01
TO SENTINEL COIN MECH. WIRING CONFIGURATION WILL VARY ACCORDING TO COUNTRY
CN2
+12 VDC
+12VDC
GND
SW RET
SW DRV
FOR USA 2 SLOT COIN DOOR ONLY
WHT CONNECTOR TO $ BILL VALIDATOR
LINE VOLTAGE (AC)
BLK
WHT
112-5001-00
1N4001 DIODE
DIODE
GRN/BRN
WHT/GRN
TO COIN METER
I/O DRVR BD J1-7 +5VDC
I/O DRVR BD J2-10 GDI
22 RED
28 VIO/GRY
N.C.
SHAKER MOTOR
I/O BD J8
Q7
SHAKER MOTOR 12VDC
FUSE 2.5A
DIODE 1N5404
VDD
RESISTOR 5.0K
SHAKER MOTOR BD 520-5065-00
BRN/VIO
RED/WHT +16 VAC FROM TRANSFORMER

Printed Circuit Boards (PCBs)

2-Flipper Wiring Diagram

New Solid State Flipper Board

We have redesigned our **Solid State Flipper Board (SSFB)** so that a misadjustment or failure of the **End-of-Stroke (EOS) Switch** will not affect the operation of the flippers. The flippers will still work! The **EOS Switch** is strictly an added feature, not a functional part of the circuit (see EOS Switch Theory of Operation).

Theory of Operation for the Solid State Flippers

The Solid State Flipper Board is a Multiple Flipper Solenoid Driver Circuit. Each solenoid driver circuit contains a One Shot Timer, a 50V Driver, and an 8V Driver.

Looking at one circuit, Schmidt NAND gates U1A, U1b, and U1D make up the One Shot Timer. The timer length is controlled by R10, R33 and C2. The output of the timer is gated at U1C with the buffered switch input from Q6. The output of U1C controls the 50V driver circuit consisting of Q4, Q1, Q2, Q3, and D1. As long as the flipper button is activated, Q6 will keep the 8V driver circuit, SR1, on.

The 50 volts provides the actuation power to the flipper solenoid while the 8 volts provides the holding power.

Theory of Operation for the EOS Switch

The **End of Stroke (EOS) Switch** used in our flipper circuit is a Gold Peened Contact, Blade Switch Assembly, mounted on the flipper assembly.

Electrically, it is connected in series with the Cabinet Flipper Switch and the Flipper EOS input on the Solid State Flipper Board (SSFB) connector CN1 which enables the 50 Volt DC Drive Circuit.

Refering to the Flipper Wiring Diagram, one side of the Flipper Cabinet Switch is connected to ground (BLK-Wire), the other side (BLU-VIO Wire) is connected to the flipper switch input on the SSFB Connector CN1 which enables your 9 Volt DC holding voltage and is connected in series to the EOS switch which is a normally closed switch.

The function of the EOS Switch is to prevent the flipper bat from being knocked back by a high velocity shot on the playfield. If while holding the flipper in the up position, the bat is moved back 1/16" or more, the EOS Switch will close giving the coil another 50 Volt pulse.

EOS Switch Adjustment

The switch contacts should be adjusted so that when the solenoid is energized, the contacts stay closed for almost the full travel of the plunger. The contacts should open 1/16" before the plunger bottoms out or reaches maximum travel.

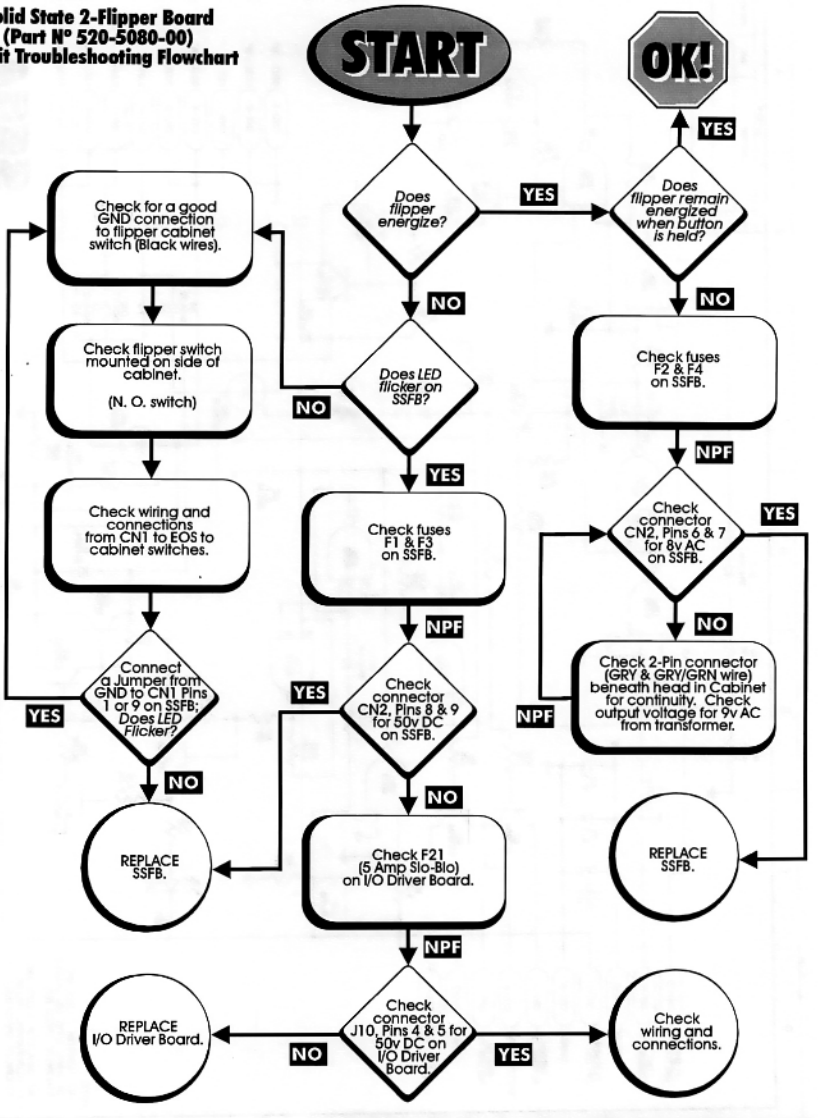
Troubleshooting Tips

The only indication of a problem you will have is the player complaining that when the flipper bat is being held in the up position, a high velocity shot from one of the playfield solenoids causes the ball to hit the flipper bat and physically knock it back. This will not occur if the EOS Switch is working. Check switch for alignment and continuity, replace if necessary.

Note:

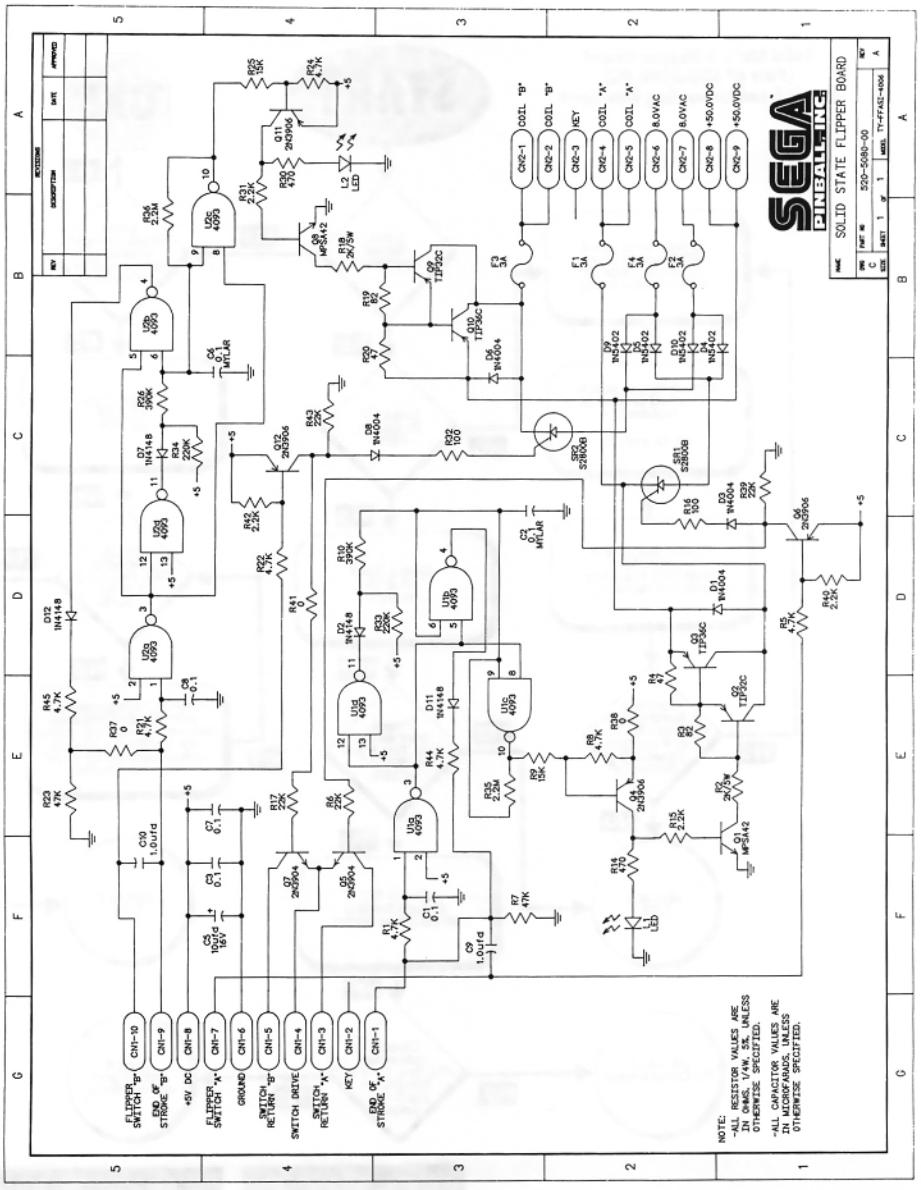
See the inside cover and the end of Section 3, Chapter 2, Diagnostics, for information on the Dr. Pinball option through the **Portals™ Service Menu for additional information and help through an additional flow chart.**

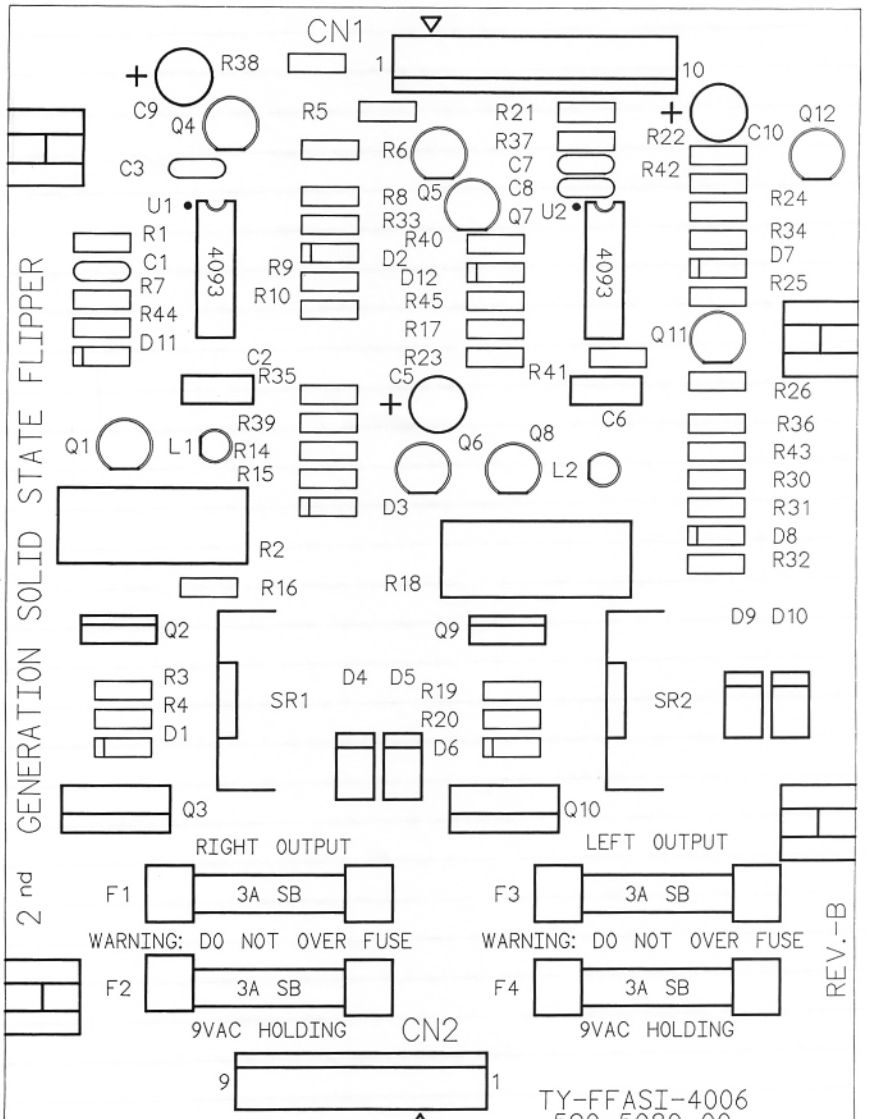
Solid State 2-Flipper Board (Part N° 520-5080-00) Circuit Troubleshooting Flowchart


START
Does flipper energize?
YES
Does flipper remain energized when button is held?
YES
OK!
NO
Check for a good GND connection to flipper cabinet switch (Black wires).
Check flipper switch mounted on side of cabinet. (N. O. switch)
Check wiring and connections from CN1 to EOS to cabinet switches.
Connect a Jumper from GND to CN1 Pins 1 or 9 on SSFB. Does LED Flicker?
YES
NO
REPLACE SSFB.
Does LED flicker on SSFB?
NO
YES
Check fuses F1 & F3 on SSFB.
NPF
Check connector CN2, Pins 8 & 9 for 50v DC on SSFB.
YES
NO
Check F21 (5 Amp Slo-Blo) on I/O Driver Board.
NPF
Check connector J10, Pins 4 & 5 for 50v DC on I/O Driver Board.
NO
YES
REPLACE I/O Driver Board.
Check wiring and connections.
Check fuses F2 & F4 on SSFB.
NPF
Check connector CN2, Pins 6 & 7 for 8v AC on SSFB.
YES
NO
Check 2-Pin connector (GRY & GRY/GRN wire) beneath head in Cabinet for continuity. Check output voltage for 9v AC from transformer.
NPF
REPLACE SSFB.

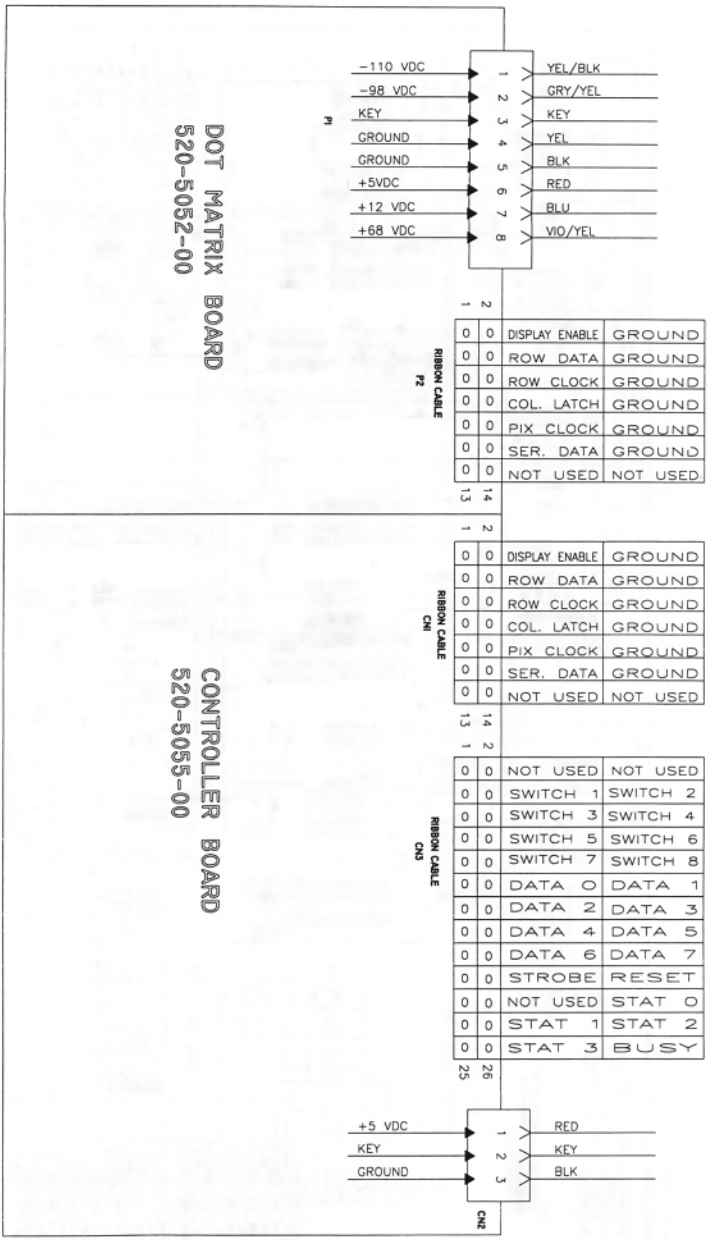
SEE GLOSSARY OF TERMS FOR UNKNOWN ACRONYMS.

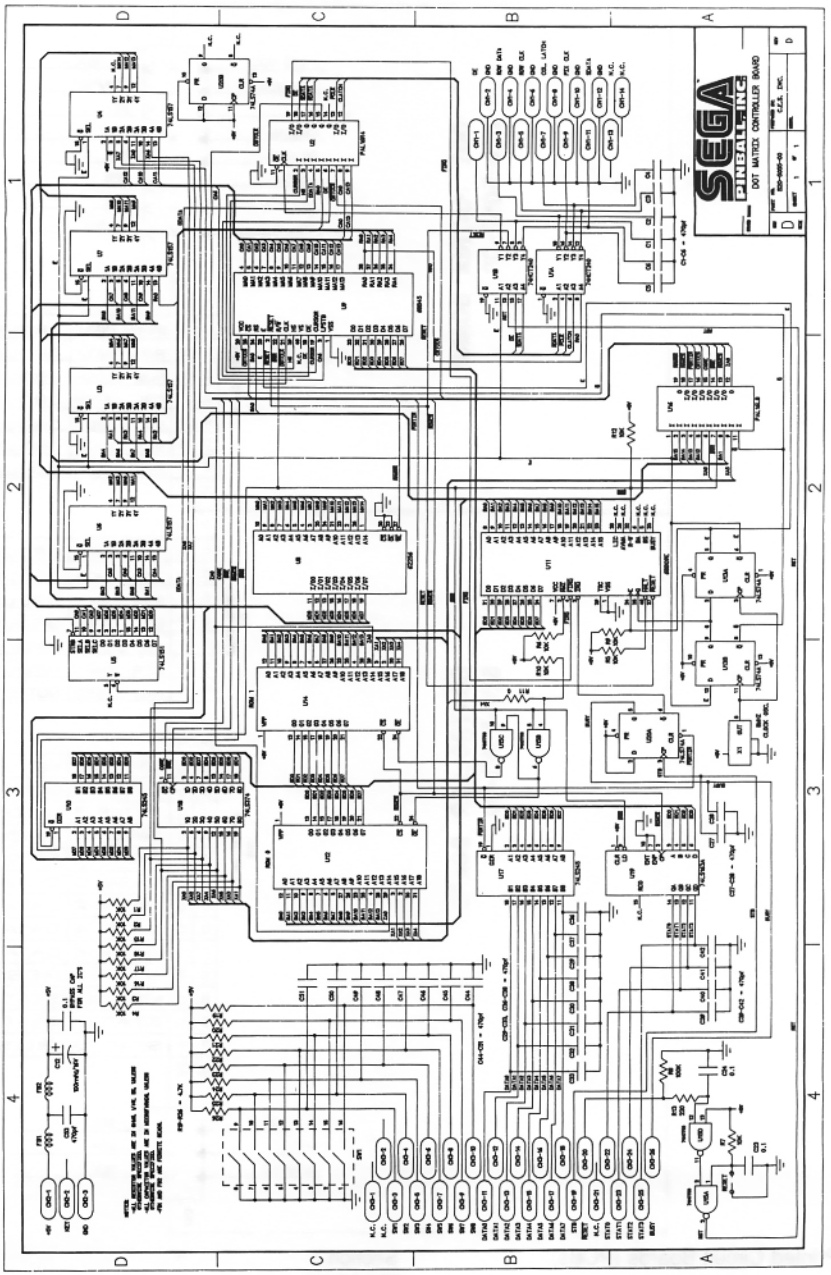
FOR FURTHER REFERENCE, SEE 2-FLIPPER WIRING DIAGRAM.

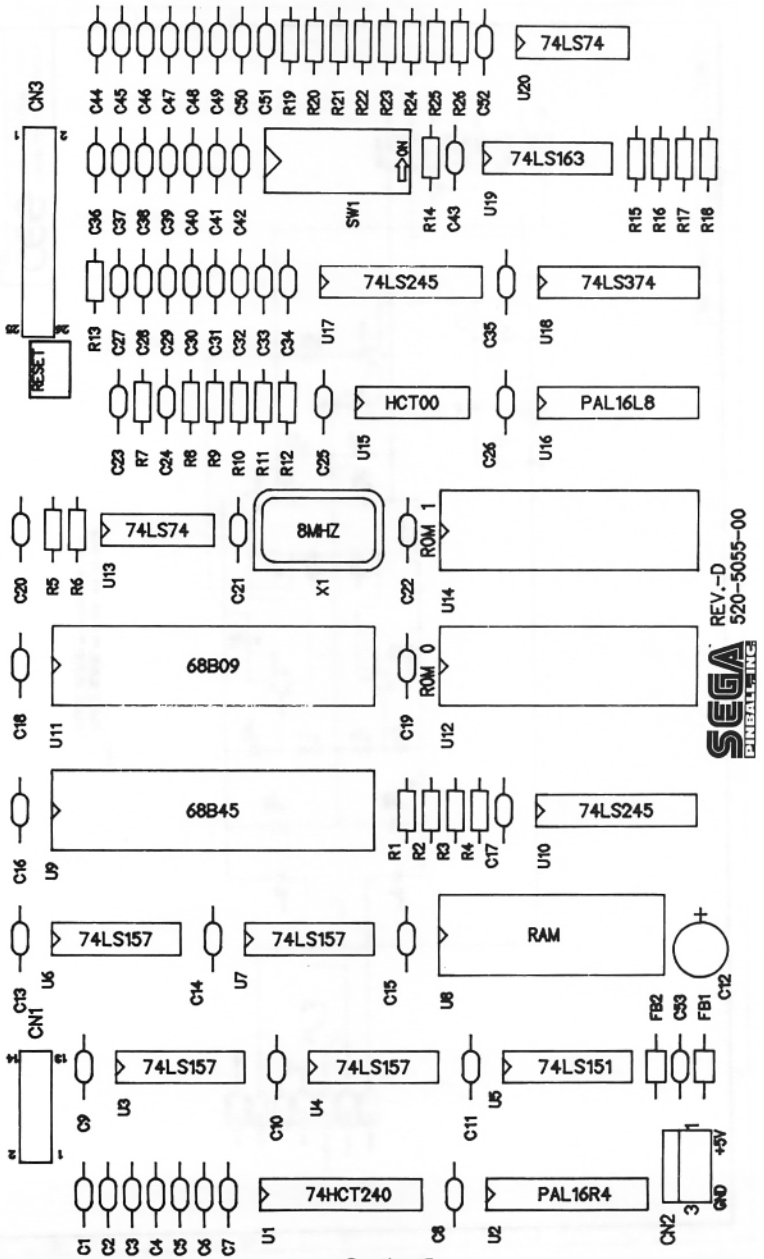

SEGA
PINBALL INC.
SOLID STATE FLIPPER BOARD
520-5080-00
NOTE:
-ALL RESISTOR VALUES ARE IN OHMS, 1/4W, 5% UNLESS OTHERWISE SPECIFIED.
-ALL CAPACITOR VALUES ARE IN MICROFARADS, UNLESS OTHERWISE SPECIFIED.
FLIPPER SWITCH "B"
END OF STROBE "B"
+5V DC
FLIPPER SWITCH "A"
GROUND
SWITCH RETURN "B"
SWITCH DRIVE
SWITCH RETURN "A"
KEY
END OF STROBE "A"
COIL "B"
COIL "A"
8.0VAC
+50.0VDC

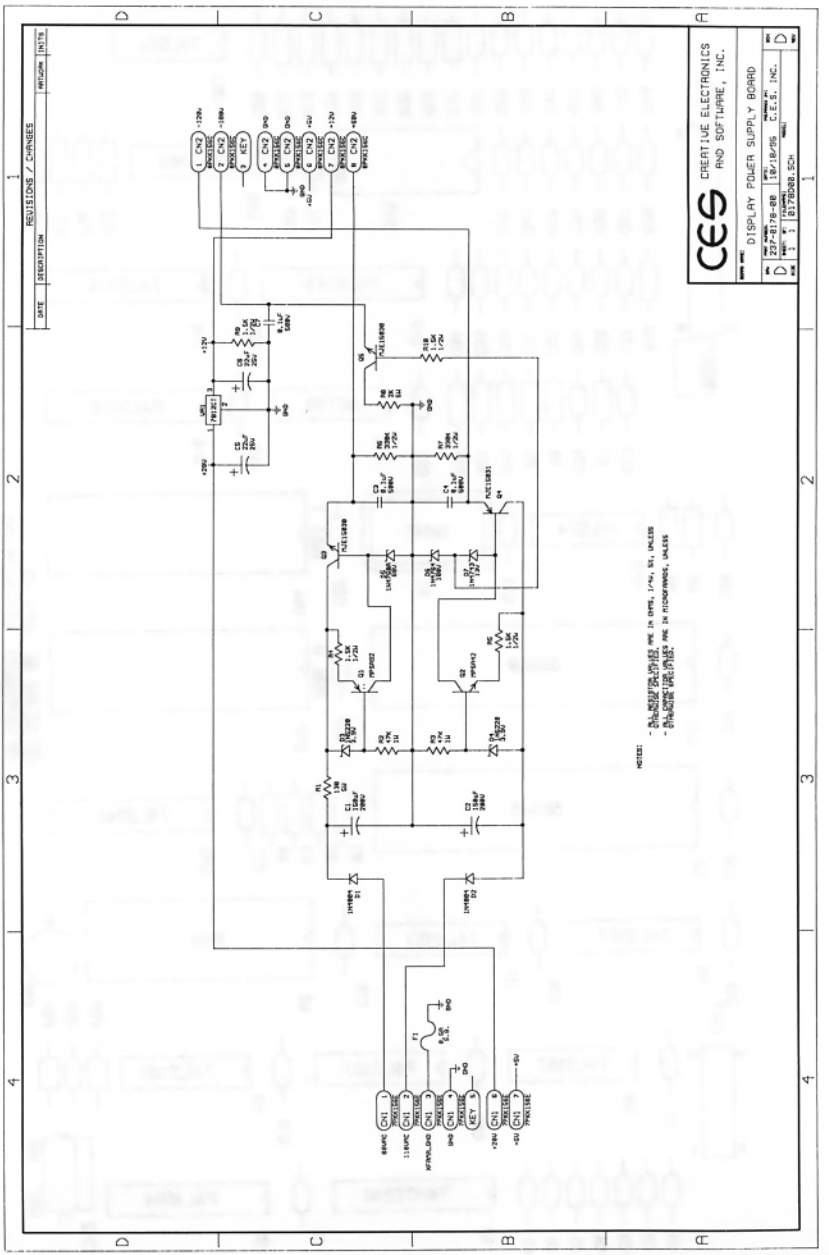

CN1
1
10
R38
C9
Q4
C3
R5
R6
R8
Q5
R33
R40
D2
D12
R45
R17
R23
C5
Q6
D3
R21
R37
C7
C8
Q7
U2
4093
R22
C10
Q12
R42
R24
R34
D7
R25
Q11
R26
C6
R41
Q8
L2
R36
R43
R30
R31
D8
R32
D9 D10
U1
R1
C1
R7
R44
D11
4093
R9
R10
C2
R35
R39
Q1
L1
R14
R15
R2
R16
R18
Q2
Q9
R3
R4
D1
SR1
D4 D5
R19
R20
D6
SR2
Q3
Q10
RIGHT OUTPUT
LEFT OUTPUT
F1
3A SB
F3
3A SB
WARNING: DO NOT OVER FUSE
WARNING: DO NOT OVER FUSE
F2
3A SB
F4
3A SB
9VAC HOLDING
9VAC HOLDING
CN2
9
1
TY-FFASI-4006
520-5080-00
2 nd GENERATION SOLID STATE FLIPPER
REV.-B

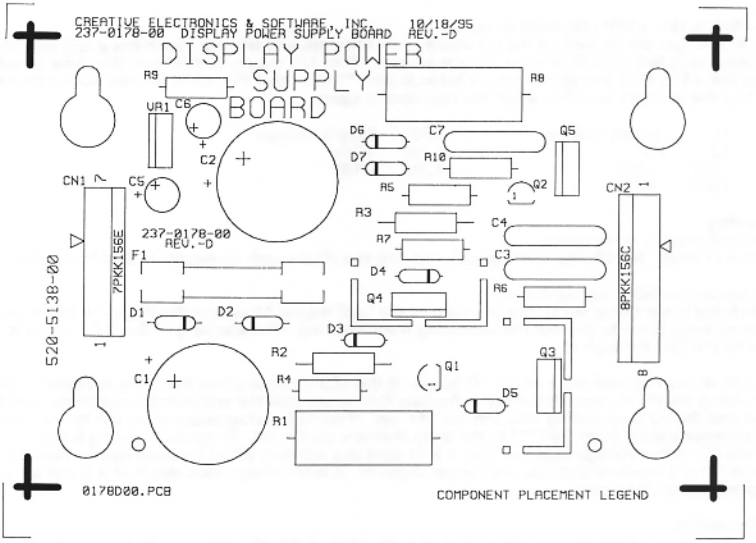
Your Notes


DOT MATRIX BOARD
520-5052-00
P1
-110 VDC
-98 VDC
KEY
GROUND
GROUND
+5VDC
+12 VDC
+68 VDC
1 2 3 4 5 6 7 8
YEL/BLK
GRY/YEL
KEY
YEL
BLK
RED
BLU
VIO/YEL
RIBBON CABLE
P2
1 2
13 14
DISPLAY ENABLE GROUND
ROW DATA GROUND
ROW CLOCK GROUND
COL. LATCH GROUND
PIX CLOCK GROUND
SER. DATA GROUND
NOT USED NOT USED
CONTROLLER BOARD
520-5055-00
RIBBON CABLE
CN1
1 2
13 14
DISPLAY ENABLE GROUND
ROW DATA GROUND
ROW CLOCK GROUND
COL. LATCH GROUND
PIX CLOCK GROUND
SER. DATA GROUND
NOT USED NOT USED
RIBBON CABLE
CN3
1 2
25 26
NOT USED NOT USED
SWITCH 1 SWITCH 2
SWITCH 3 SWITCH 4
SWITCH 5 SWITCH 6
SWITCH 7 SWITCH 8
DATA 0 DATA 1
DATA 2 DATA 3
DATA 4 DATA 5
DATA 6 DATA 7
STROBE RESET
NOT USED STAT 0
STAT 1 STAT 2
STAT 3 BUSY
+5 VDC
KEY
GROUND
1 2 3
RED
KEY
BLK
CN2


SEGA
PINBALL
DOT MATRIX CONTROLLER BOARD


74LS74
U20
CN3
C44 C45 C46 C47 C48 C49 C50 C51 R19 R20 R21 R22 R23 R24 R25 R26 C52
SW1
ON
74LS163
U19
C36 C37 C38 C39 C40 C41 C42
R14 C43
R15 R16 R17 R18
RESET
R13 C27 C28 C29 C30 C31 C32 C33 C34
74LS245
U17
C35
74LS374
U18
C23 R7 C24 R8 R9 R10 R11 R12 C25
HCT00
U15
C26
PAL16L8
U16
C20 R5 R6
74LS74
U13
C21
8MHZ
X1
C22
ROM 1
U14
REV.-D
520-5055-00
SEGA
C18
68B09
U11
C19
ROM 0
U12
C16
68B45
U9
R1 R2 R3 R4 C17
74LS245
U10
C13
74LS157
U6
C14
74LS157
U7
C15
RAM
U8
FB2 C53 FB1 C12
CN1
74LS157
U3
74LS157
U4
74LS151
U5
C9
C10
C11
+5V
GND
CN2
C1 C2 C3 C4 C5 C6 C7
74HCT240
U1
C8
PAL16R4
U2


CREATIVE ELECTRONICS AND SOFTWARE, INC.
DISPLAY POWER SUPPLY BOARD
237-0178-00
C.E.S. INC.
REVISIONS / CHANGES
DESCRIPTION
DATE
NOTES:



ITEM	QTY	PART NUMBER	REF-DESIGNATOR	DESCRIPTION
1	1	Note:	F1	S.B. 0.5A
2	2		Q3 Q4	HEATSINKS - AAVID #563002
3	2	Part Numbers	C2 C1	200V 150uF RADIAL LYTIC
4	4	are not yet	R10 R9 R5 R4	1/2W 1.5K
5	2	yet availalbe.	R7 R6	1/2W 330K
6	2		R2 R3	1W 47K
7	1		R1	5W 130
8	1		R8	5W 2K
9	2		D3 D4	3.9V 5228
10	1		D5	68V 4760A
11	1		D6	100V 4764
12	1		D7	13V 4743
13	1		Q1	MPSA92
14	1		Q2	MPSA42
15	3		C3 C4 C7	500V 0.1uF CERAMIC DISK
16	1		Q4	MJE15031
17	2		Q3 Q5	MJE15030
18	2		C5 C6	25V 22uF RADIAL LYTIC
19	1		VR1	7812CT
20	1		CN2	8pkk156 (PIN3=KEY)
21	2		D1 D2	1N4004
22	1		CN1	7PKK156E (PIN5=KEY)
23	2		Q3 Q4	6/32 KEY NUT
24	2		Q3 Q4	6/32 X 3/8 SCREW
25	2		F1	FUSECLIPS

5V Supply:
An AC voltage of approximately 9V comes into the board at [J17-(14)]this AC voltage is then full-wave rectified by bridge BRDG21 and filtered by capacitor C203. The resulting voltage is 11VDC which is inserted into a linear voltage regulator for the output of 5VDC. This 5V regulated voltage can be adjusted by potentiometer R116 the voltage should be set to 5.00V. Besides powering the I/O board the regulated 5 volts supplies power to the CPU & Sound Board Gas Plasma Display and Plasma Controller Board. Power for these devices comes off the I/O on [J16-(4-8)].

+5 +12 +50V +18V +20V LED Indicators:
These DC voltages are derived on the I/O board by rectification and filtering. Each has a LED indicating that power is being supplied to each of these voltage sources. The -12V supply comes from the same transformer winding as the +12V thus it does not have a led indicator. ** Note that the +50V &+20V power sources are turned off by the interlock switches when the coin door is open.

LED	Supply Voltage	LED	Supply Voltage
L2	+5	L200	+20V
L201	+50V	L202	+18V
L203	+12V		

Reset Circuitry:
The I/O will reset in three cases:
1. The CPU is in reset. The CPUÆs reset signal is fed into the I/O through connector J1 and forces the I/O into reset.
2. The 5V supply has fallen bellow 4.75V.
3. The watchdog is not being fed by the scanning of the light matrix. More specifically pin 19 of U6 must be toggling once every 50ms to prevent the watchdog from resetting. The scanning of the light matrix is controlled by the CPU through J1.

LED L204 shows the reset state of the I/O board. If this LED is not lit either the 5VDC is below 4.75V or the CPU board is holding the I/O in reset. If the LED is flashing this means that the watchdog is not being feed by the CPU board and the I/O is oscillating into and out of reset. If the LED is continuously on the board is out of reset and communication from the CPU to the lamp matrix is confirmed. Testpoint Blanking is the actual reset signal on the I/O. A low voltage indicates that it is in reset this will turn off all Solenoid drivers Flash Lamps Lamp Matrix Drivers Auxiliary Outputs and Flipper Outputs. A high voltage indicates that it is out of reset and normal operation can take place.

Address Decoding:
All Address decoding is done by two 74LS138 (1 of 8 decoder). Both of these must be in operation for the I/O to function properly.

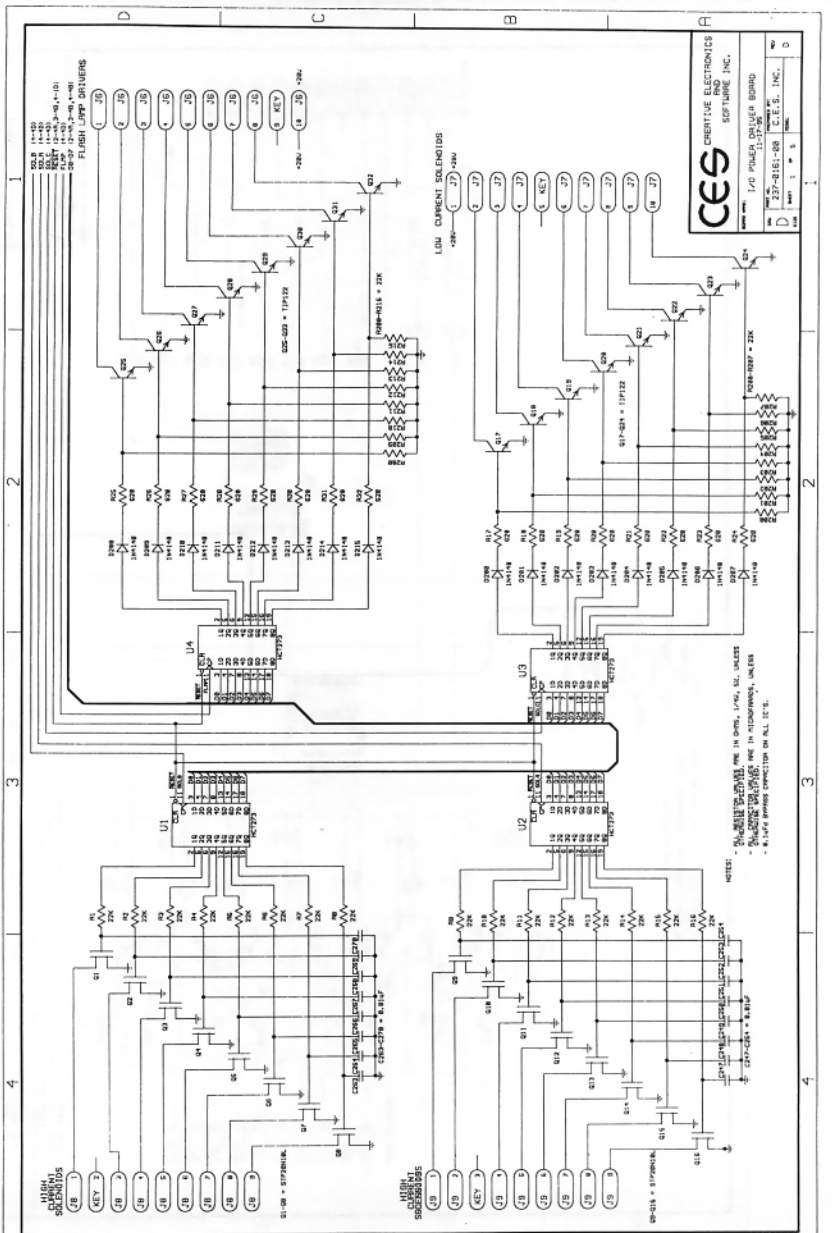
Solenoid Drivers & Flash Lamps:
J8 & J9 are low side drivers for driving solenoids and other heavy loads. Each connector has its own buffer driving 8 drivers. J8 & J9 consist of MOSFET drivers 20N10L which can easily & safely be tested by clipping one end of a clip-lead to test point FET TPL1 and then the other to the corresponding gate resistor R1-R16 (see note 1). This will apply 3.4V to the gate of the MOSFET transistor thus switching it on. J7 & J6 each are a bank of 8 low side driver for driving lamps or other lower current solenoids. They use a bipolar power transistor TIP122 which can also be tested by using test point TIP TPL3 and the corresponding resistors R17-R32 (see note 1).

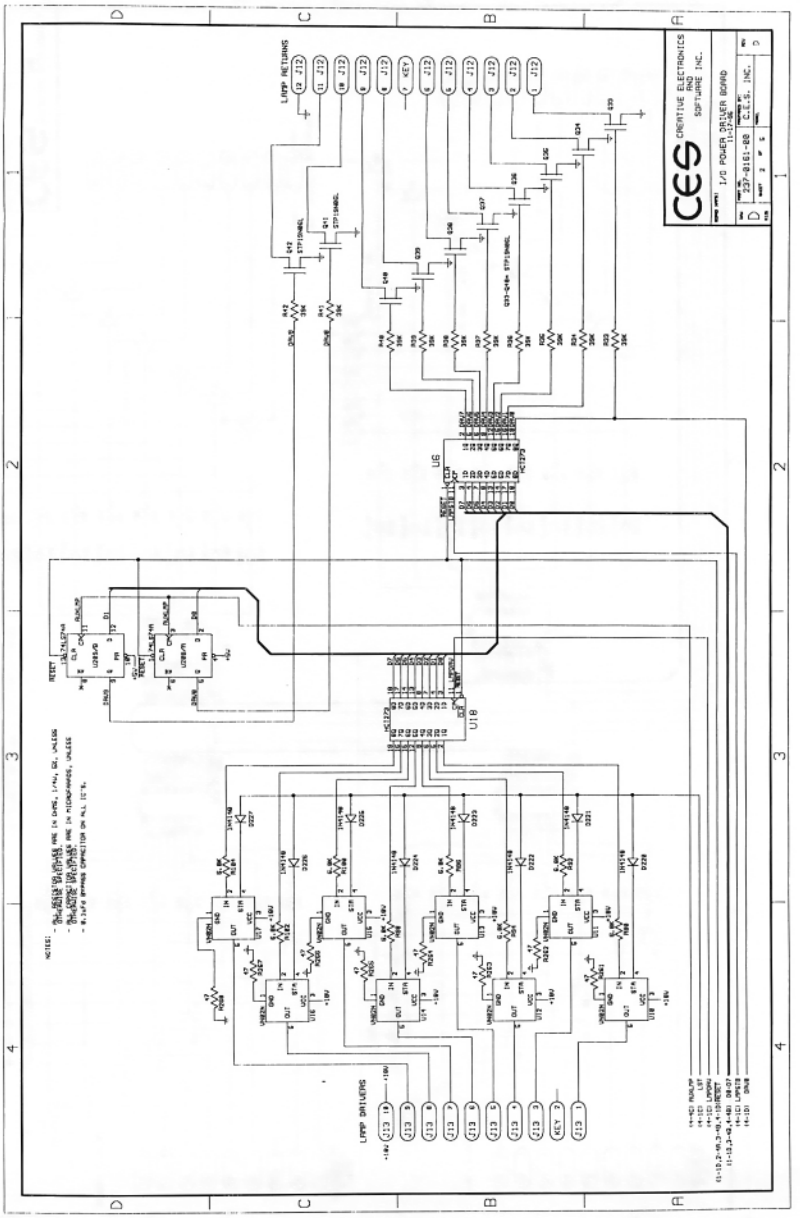
Note 1 * Clip on the resistor side with the white stripe.
** R1 controls Q1 and R2 controls Q etc...)

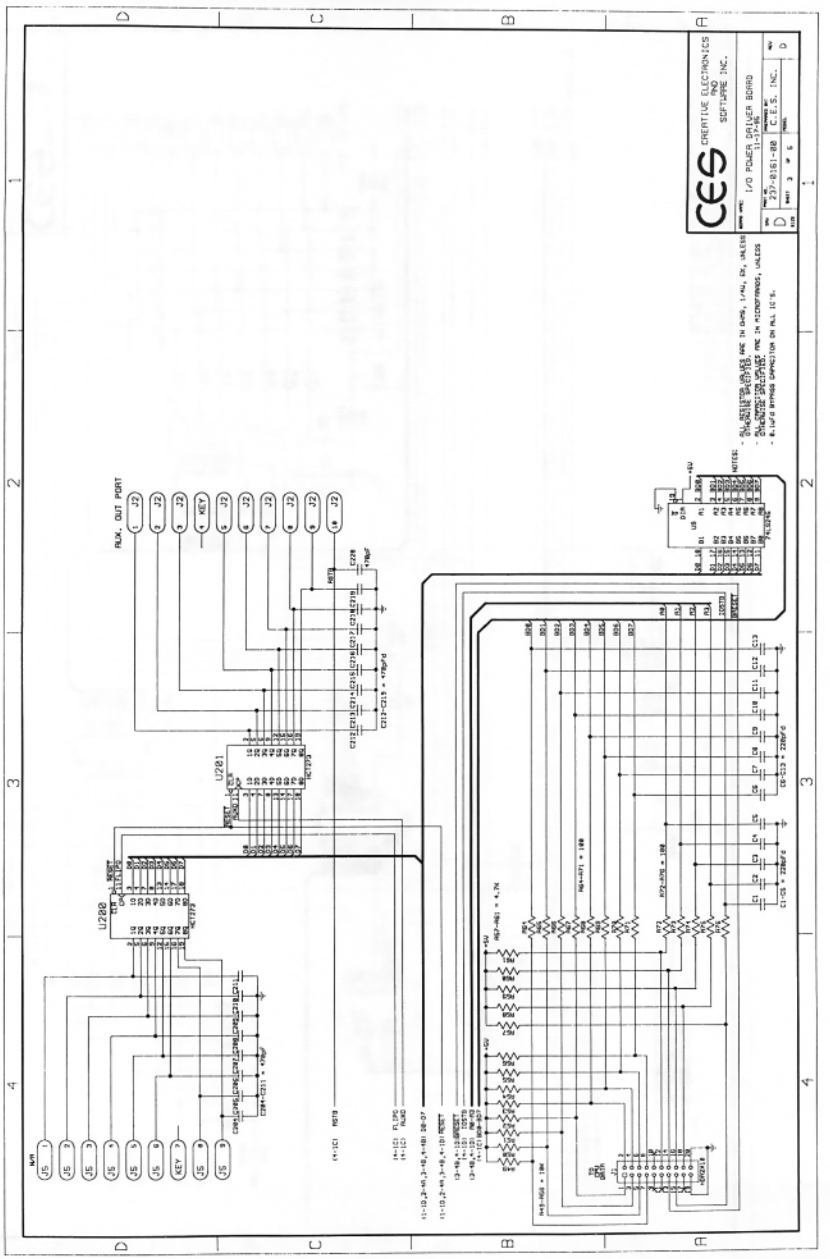
Auxiliary In & Out:
J2 8 CMOS Outputs sometimes used for a printer interface.
J3 8 CMOS Inputs general purpose inputs.

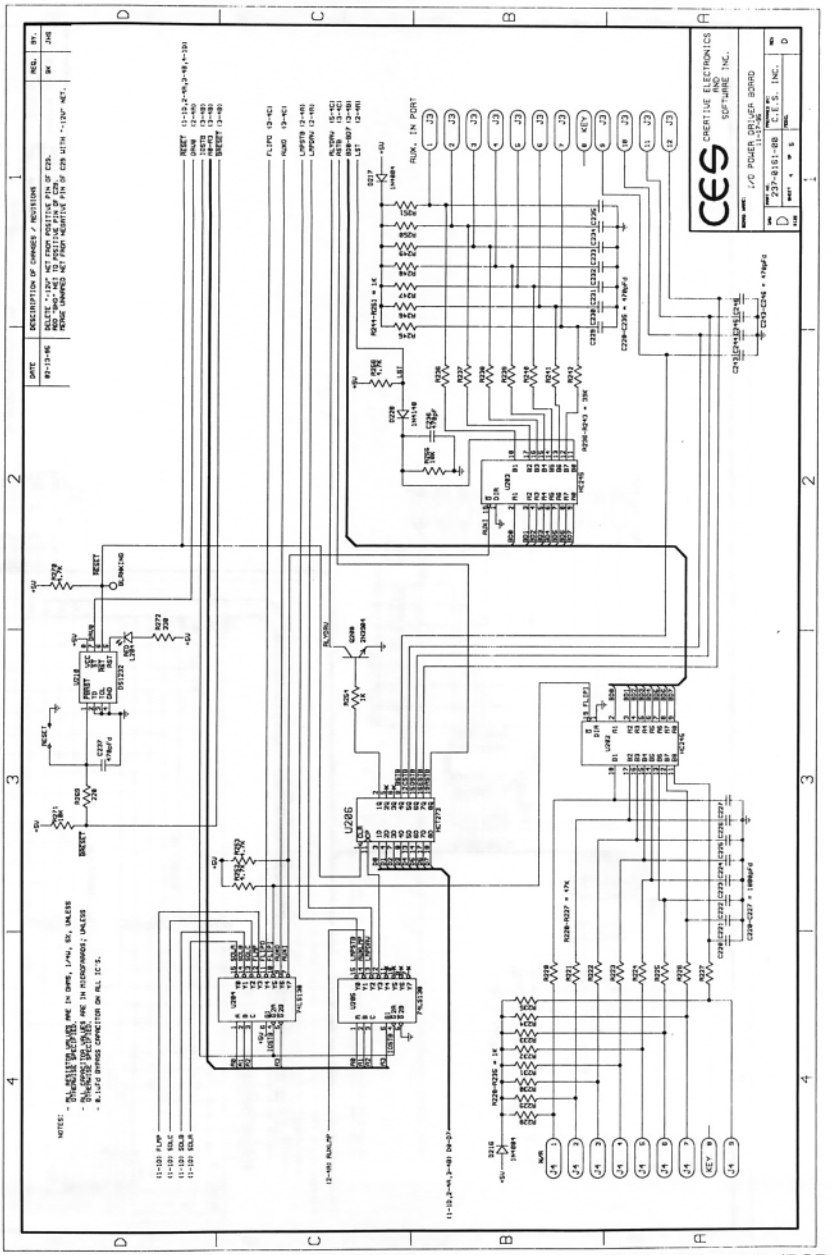
Lamp Matrix:
J12 has 10 low side drivers for the lamp strobes which consist of 19N06L MOSFETS. Only one lamp strobe should be low at any time. Again the scanning of the lamp strobes keeps the I/O from resetting. J13 has 8 high side drivers with each having a status indicator. All the status indicators are logically 'OR'ed together and fed back to the CPU. The status can identify open loads (for example open lamp filaments or intermittent connections) and short circuits. These drivers are also short-circuit protected.

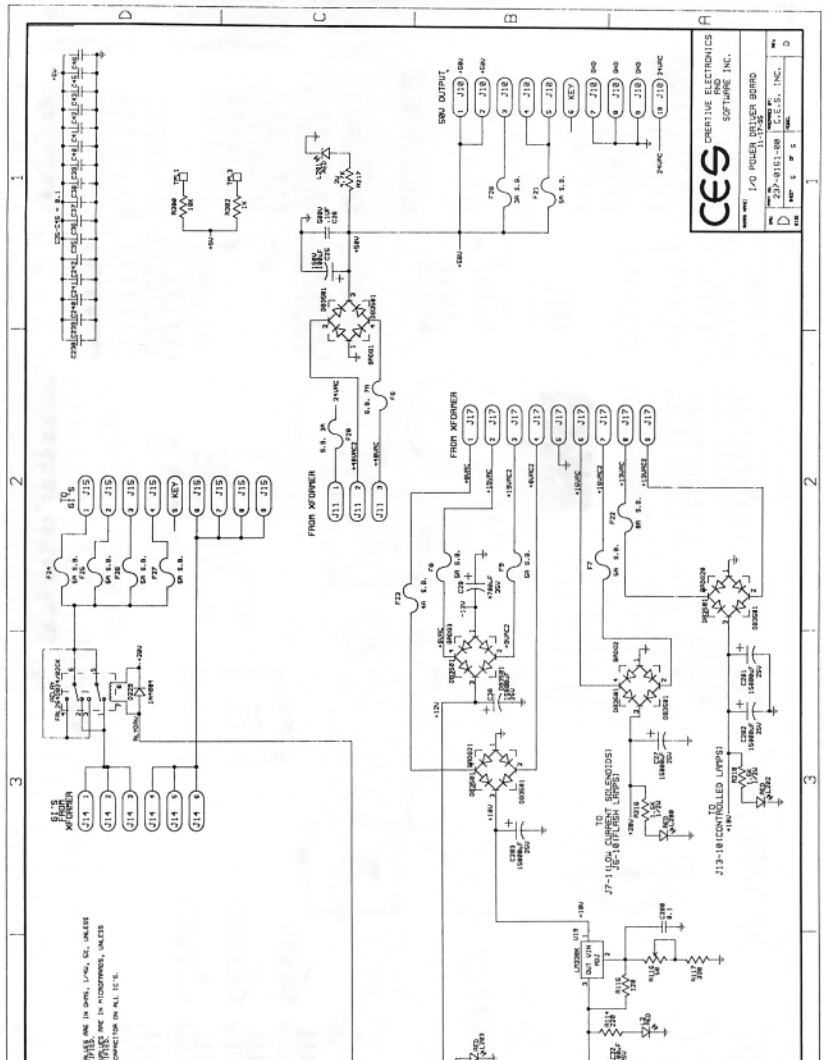
General Illumination (GI lamps):
J15 has 6VAC switched on and off by a relay on the I/O. The relay is controlled by Q200 which supplies power to the 24V coil winding to activate the relay. There are 4 taps on J15 each fused at 5A for this 6VAC source.

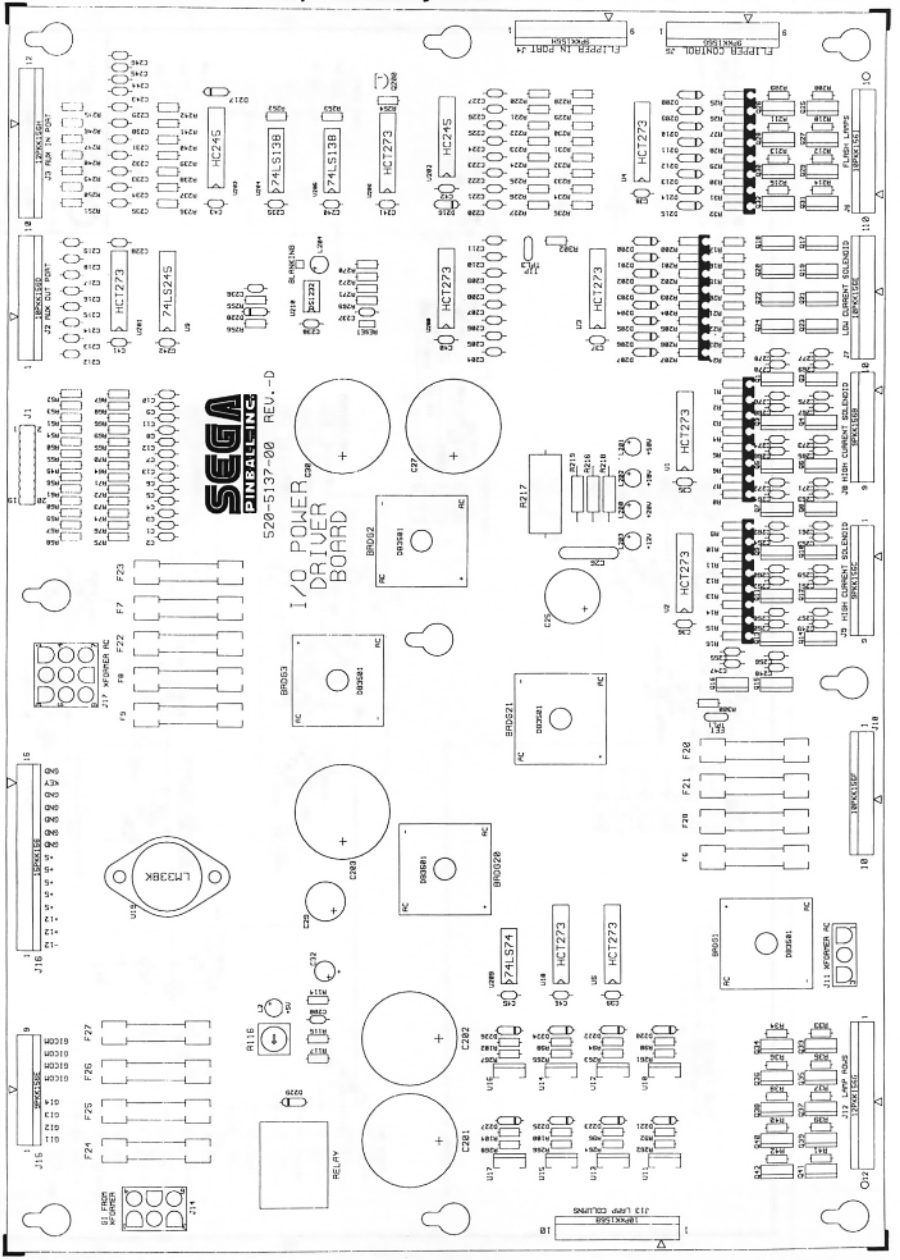

CREATIVE ELECTRONICS AND SOFTWARE INC.
I/O POWER DRIVER BOARD
27-0161-00
C.E.S. INC.
FLASH LAMP DRIVERS
LOW CURRENT SOLENOIDS
HIGH CURRENT SOLENOIDS
NOTES:








CES
CREATIVE ELECTRONICS SYSTEMS
SOFTWARE INC.
I/O POWER DRIVER BOARD
237-0161-00
C.E.S. INC.
SRV OUTPUT
FROM XFORMER
POWER OUT
TO J7-1 (LOW CURRENT SOLENOIDS)
TO J13-10 (CONTROLLED +VPPS)
FROM XFORMER
TO J15
TO J14
+5V RLYDRV


SEGA
PINBALL INC.
520-5137-00 REV.-D
I/O POWER
DRIVER
BOARD
74LS245
74LS138
74LS273
74LS374
HCT273
HC245
HCT245
LM338K
RELAY
FLIPPER CONTROL
FLIPPER IN PORT
J3 MAIN IN PORT
J2 MAIN OUT PORT
J17 XFORMER AC
J11 XFORMER AC
J13 LAMP COLUMNS
J12 LAMP ROWS
J8 HIGH CURRENT SOLENOID
J9 HIGH CURRENT SOLENOID
J7 LOW CURRENT SOLENOID
FLASH LAMPS
J14 FROM XFORMER

I/O Power Driver Board Parts

ITEM	QTY	PART NUMBER	REF-DESIGNATOR	DESCRIPTION
1	16	Note: Part Numbers	C260 C259 C258 C257 C256 C278 C271 C255 C261 C262 C277 C276 C275 C274 C273 C272	100V 104 (0.1uF)
2	30	are not yet available.	C204 C206 C207 C208 C209 C210 C211 C235 C234 C228 C229 C230 C231 C232 C233 C219 C217 C216 C215 C214 C212 C213 C237 C218 C236 C205 C243 C245 C246 C244	471 (470pF)
3	16		C263 C264 C265 C270 C269 C268 C267 C266 C247 C254 C253 C252 C251 C250 C249 C248	103 (0.01uF)
4	13		C7 C8 C9 C10 C11 C12 C13 C1 C2 C3 C4 C5 C6	221 (220pF)
5	8		C227 C226 C220 C221 C222 C223 C224 C225	102 (0.001uF)
6	17		C35 C36 C37 C38 C39 C40 C41 C42 C43 C45 C46 C200 C239 C238 C240 C241 C242	104 (0.1uF)
7	16		Q1 Q2 Q3 Q4 Q5 Q6 Q7 Q8 Q16 Q15 Q14 Q13 Q12 Q11 Q10 Q9	20N10L
8	32		R2 R3 R4 R5 R6 R7 R8 R16 R15 R14 R13 R12 R11 R10 R9 R200 R201R202 R203 R204 R205 R206 R207 R215 R214 R213 R212 R211 R210 R209 R208 R1	22K
9	16		R17 R32 R18 R19 R20 R21 R22 R23 R24 R31 R30 R29 R28 R27 R26 R25	620
10	17		R237 R236 R40 R39 R38 R37 R36 R35 R34 R33 R238 R239 R240 R241 R242 R42 R41	39K
11	13		R64 R72 R73 R74 R75 R76 R71 R70 R69 R68 R67 R66 R65	100
12	8		R90 R92 R94 R96 R98 R100 R102 R104	6.8K
13	1		R115	120
14	8		R221 R220 R222 R223 R224 R225 R226 R227	47K
15	17		R254 R248 R249 R250 R251 R232 R246 R247 R245 R233 R234 R235 R230 R231 R228 R229 R302	1K
16	8		R262 R261 R263 R264 R265 R266 R267 R268	47
17	2		R269 R114	220
18	9		R57 R58 R59 R60 R61R252 R253 R256 R270 R49	4.7K
19	11		R271 R56 R55 R54 R53 R52 R51 R50 R255 R300	10K
20	2		R117 R272	330
21	9		U6 U4 U18 U2 U1 U200 U3 U201 U206	HCT273
22	1		RESET	DO NOT STUFF
23	1		R219	1/4W 1K
24	2		R218 R216	1/2W 1.5K
25	8		F24 F25 F26 F27 F8 F9 F7 F21	S.B. 5A
26	1		F6	S.B. 7A
27	1		F23	S.B. 4A
28	1		F22	S.B. 8A
29	2		F20 F28	S.B. 3A
30	1		J15	9PKK156 (PIN 5=KEY)
31	1		J16	15PKK156
32	1		U210	DS1232
33	1		Q200	2N3904
34	1		C32	25V 100uF RADIAL LYTIC
35	1		J1	20 PIN 0.1 DUAL ROW HEADER
36	2		U202 U203	HC245
37	10		Q41 Q33 Q34 Q35 Q36 Q37 Q38 Q39 Q40 Q42	19N06L
38	6		L203 L202 L204 L200 L2 L201	RED LED
39	1		J2	10PKK156 (PIN 4=KEY)
40	1		R116	50 OHM POT
41	16		Q23 Q22 Q21 Q20 Q19 Q18 Q26 Q27 Q28 Q29 Q30 Q31 Q32 Q17 Q25 Q24	TIP122
42	1		C25	150V 100uF RADIAL LYTIC
43	1		U9	74LS245
44	1		C29	35V 4700uF RADIAL LYTIC
45	1		RELAY	FRL264D024/02CK RELAY
46	1		J5	9PKK156 (PIN 7=KEY)
47	1		U209	74LS74
48	1		J4	9PKK156 (PIN 8=KEY)
49	2		U204 U205	74LS138
50	1		C26	500V .1UF CERAMIC DISK
51	1		U19	LM338K
52	5		BRDG20 BRDG3 BRDG1 BRDG2 BRDG21	DB3501
53	5		C202 C203 C201 C30 C27	25V 15000uF RADIAL LYTIC
54	25		D208 D225 D226 D221D220 D223 D227 D224 D222 D200 D201 D202 D203 D204 D205 D206 D207 D209 D210 D211 D212 D213 D214 D215 D228	1N4148
55	3		D217 D216 D229	1N4004
56	2		TPL3 TPL1	TEST POINT LOOPS
57	1		J7	10PKK156 (PIN 5=KEY)
58	1		J6	10PKK156 (PIN 9=KEY)
59	8		U17 U16 U15 U14 U13 U12 U11 U10	VN02N
60	1		J11	10-84-4030 (3 PIN MOLEX)
61	1		J12	12PKK156 (PIN 7=KEY)
62	1		J17	10-84-4090 (9 PIN MOLEX)
63	1		BLANKING	TEST POINT - DO NOT STUFF
64	1		R217	2W 4.7K SANDBAR
65	1		J13	10PKK156 (PIN 2=KEY)
66	1		J14	10-84-4060 (6 PIN MOLEX)
67	1		J10	10PKK156 (PIN 6=KEY)
68	1		J3	12PKK156 (PIN 8=KEY)
69	1		J9	9PKK156 (PIN 3=KEY)
70	1		J8	9PKK156 (PIN 2=KEY)
71	26			FUSECLIPS
72	1		U19	HEATSINK

CPU Section:
The CPU is a 68B09E (U209) with up to 8Mbytes of CPU code space (U210). The CPU code is bank selected by the use of U211and each bank consists of 16Kbytes. 8Kbytes of RAM (U212) is available to the CPU. The RAM is battery backed and has a write protected area. Battery back up is accomplished by 3-AA Cells which have a test point VB to check the battery voltage status. The write protected area consists of 512 Bytes used for storing game settings. This section of RAM can only be written to when the coin door is open. The coin door switch comes into the CPU on CN6-12 and is fed into the address decoding PAL U213. When this memory protect signal is low writes to the protected RAM area are prohibited. Address decoding for the system is accomplished by one PAL U213 and one 1-of-8 decoder U214.

A watchdog is used to monitor the CPU and the 5V supply. If the 5V supply is below 4.75 the watchdog will hold the CPU board & I/O board in reset. The watchdog must be fed at a rate of 250ms or faster. The signal used to feed the watchdog comes from the EPROM bank select signal used to load U211. The CPU has a timer interrupt used as a heartbeat for the system this signal comes from counter U2. The clock for this counter is the CPU Q clock. Clearing the timer interrupt is done by reading the DIP switch. The timer interrupt can be observed at test point FIRQ. In normal operation "FIRQ" should be toggling at a rate of 976Hz.

The I/O interface CN1 is buffered by 2 HC245 chips. The CPU's reset line is buffered by Q10 and fed over to the I/O through CN1. An I/O strobe signal is feed through CN1-15 and is used to notify the I/O that a valid address is being sent.

Switches:
The switch-matrix consists of 8 2N3904 transistors which pull one of eight stobes low to activate a single column of switches. The switch return signals are fed into CN7 and are highly filtered and compared to a 2.5V reference voltage. The switch return voltage must be below 2.5V to make a valid switch closer. If false switches are appearing check that none of the 2N3904 transistors are permanently pulling the strobe line low. Only one strobe from CN5 should be low at any time. CN6 is a dedicated bank of input switches. Switches connected to CN6 are connected to ground instead of a strobe and may be read at any time.

Plasma Interface:
The data path for communication to and from the plasma controller is 8bits wide. There are separate input and output busses. The input bus from the plasma controller to the CPU comes in on [CN8-(3-10)] and is fed into U200 for input to the CPU's data bus. Data going out to the controller comes from the CPU's data bus through U201 and onto [CN8-(11-18)]. Status back from the plasma comes in on [CN8-(22-26)]and is fed into U202 for input to the CPU's data bus. Two control signals that go out to the plasma controller are PRES (Plasma Reset) and PSTB (Plasma Strobe). Plasma Reset is software controllable through U216/B and also has a test point "Plasma Reset". The Plasma Strobe signal to the controller is generated from U216/A and is used to latch data into the plasma controller.

Sound Section:
The audio section consists of a BSMT sound chip U9 Sound EPROMs (U17 U21 U36 U37) 68B09E U6 and Sound Code EPROM U7. The BSMT latches sound EPROM addresses in U13 & U12 for output to the Sound EPROMs. Sound Data from the EPROMs is read through U19 to the BSMT. The EPROMs are bank selected by U22. When the BSMT has sound data to be played out to the speakers it loads 16 bits into a 16 bit shift register made up of U24 & U23. The data stream from the shift register is serially shifted into a stereo 16 bit Digital to Analog Converter (DAC). When the system is operating properly the ws(word select) input of the DAC will be toggling. The ws input is used to latch the right and left channel sound data into the DAC. If the ws line is not oscillating no analog signal will come out of the DAC. The DAC outputs are a controlled current source. These outputs are converted to a voltage by an operational amplifier U30 to form the analog signal. Test points AOR and AOL are the outputs of the operational amplifier. These outputs are then fed directly into three power amplifiers (TDA2030A) or optionally into an analog volume control chip U35 for a potentiometer volume control. The analog section has its own +5V & -5V derived from VR1 & VR2. These separate supply voltages are for the DAC U26 Operational Amplifier U30 and analog volume control U35.

Sound calls are made from the CPU's 68B09E U200 to the sound section by latching data into U5. The sound section's CPU 68BO9E (U6) reads in this data and handles the interfacing to the BSMT.

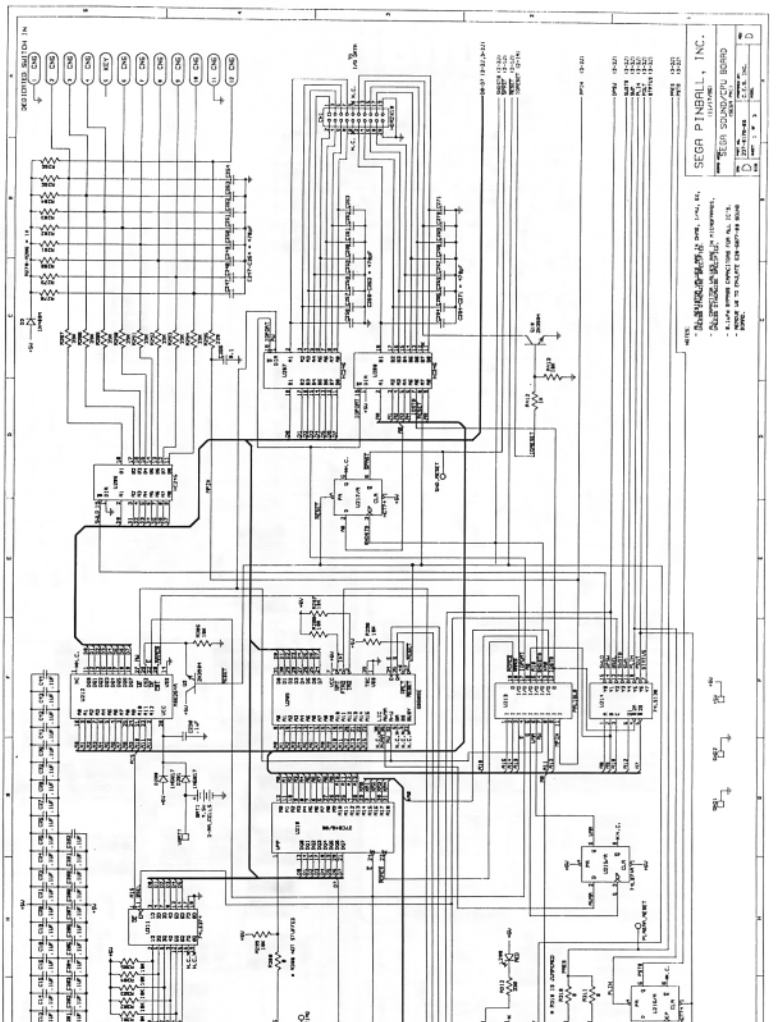
Other Test Points:
E & Q - The CPU signals for both 68B09E processors. Should be at 2Mhz with Q leading E by 500 nsec.

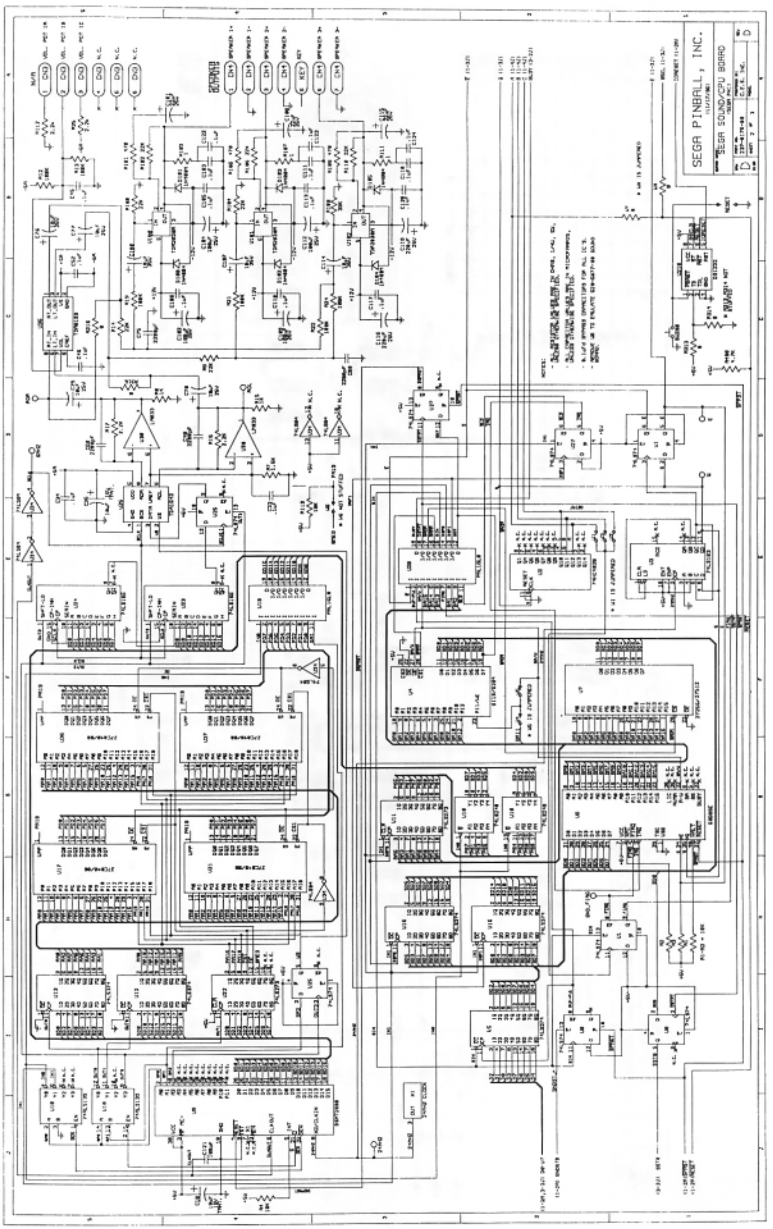
24Mhz - The oscillator used for the BSMT & derivation of E & Q.

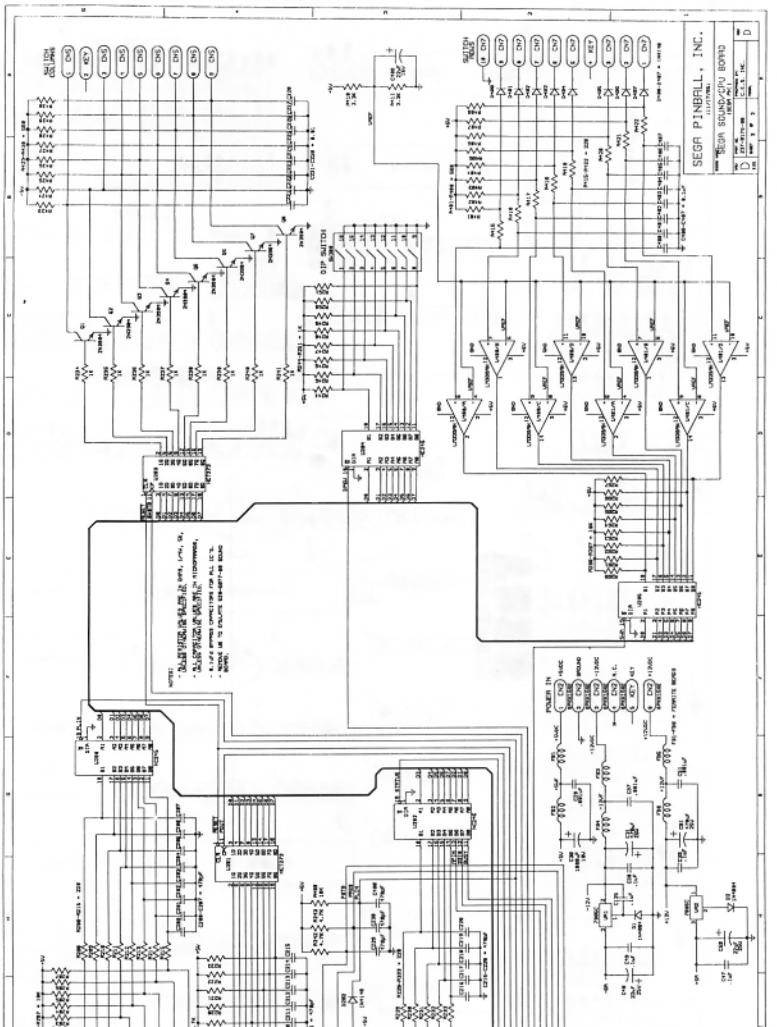
SND-FIRQ - The sound sections CPU interupt.

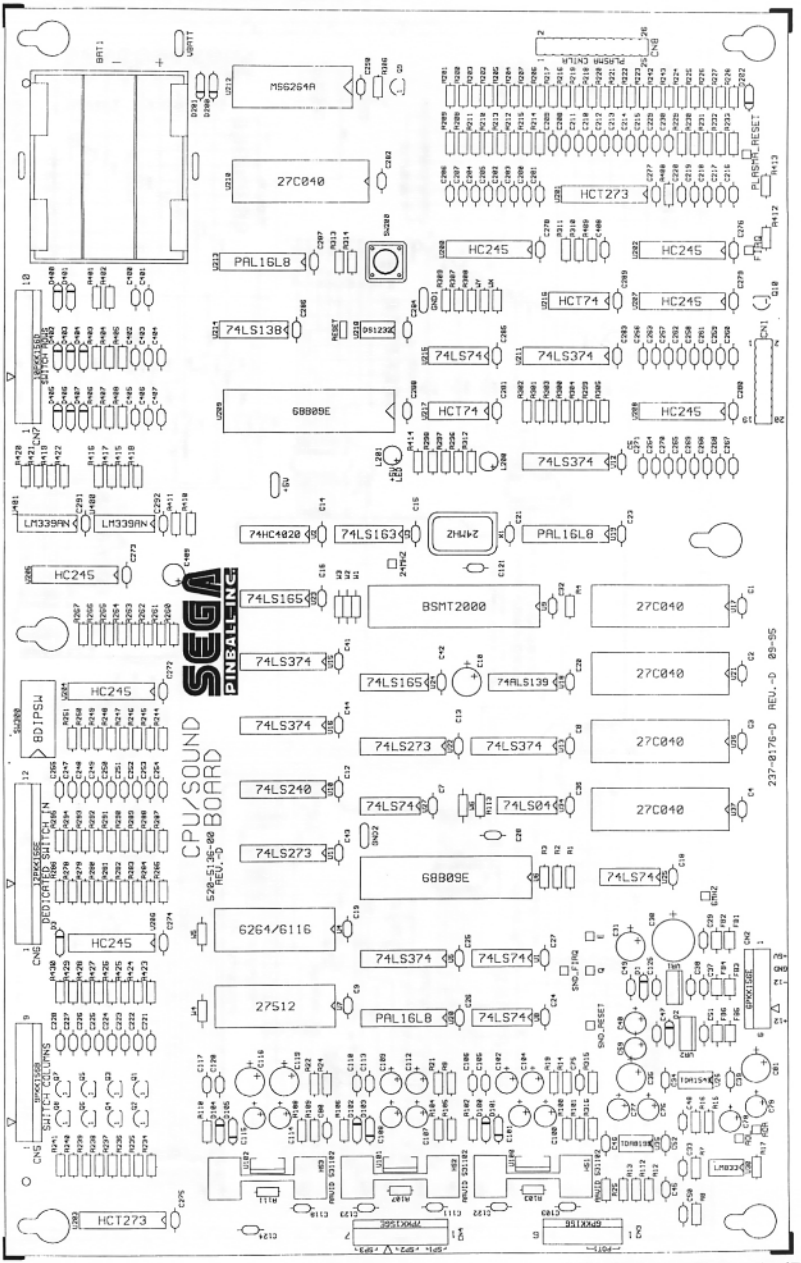
6Mhz - This clock is generated internally on the BSMT and is used for shifting the data samples into th DAC.

CPU/Sound Board Schematic (Sheet 1 of 3)




SEGA PINBALL, INC.


SEGA PINBALL INC.
SOUND/CPU BOARD


SEGA
PINBALL INC.
CPU/SOUND BOARD
520-5136-00 REV.D
237-8176-D REV.-D 09-95
BSMT2000
68B09E
6264/6116
27512
27C040
HCT273
HC245
HCT74
74LS374
74LS273
74LS165
74LS240
74LS74
74LS04
74LS139
74LS163
74HC4020
74LS165
74LS138
PAL16L8
MS6264A
LM339AN
24MHZ
DS1232
BDIPSW
DEDICATED SWITCH
SWITCH COLUMNS
SWITCH MATRIX
PLASMA RESET
SND_RESET
SND_FIRQ

CPU/Sound Board Parts

ITEM	QTY	PART NUMBER	REF-DESIGNATOR	DESCRIPTION
1	1	Note:	VR2	7805
2	6		R13 R24 R21 R12 R19 R22	100K
3	3	Part Numbers	R111 R103 R107	1
4	46	are not yet available.	R4 R3 R2 R1 R113 R306 R301 R302 R303 R305 R304 R299 R296 R298 R297 R247 R248 R249 R251 R250 R246 R245 R244 R266 R267 R265 R264 R263 R228 R227 R226 R225 R224 R200 R201 R202 R203 R204 R205 R206 R207 R262 R261 R260 R409 R413	10K
5	7		R14 R104 R110 R102 R100 R106 R9	22K
6	20		R15 R8 R241 R240 R239 R238 R237 R236 R235 R234 R278 R279 R280 R281 R282 R283 R285 R286 R284 R412	1K
7	4		R25 R17 R16 R112	2.2K
8	1		R7	1.5K
9	3		R105 R101 R109	R470
10	9		R108 R294 R293 R292 R291 R290 R289 R288 R287	39K
11	1		R312	330
12	12		R311 R310 R307 R309 R308 R300 R313 R316 R315 R314 WX WY	0
13	23		R295 R229 R230 R231 R232 R233 R215 R214 R213 R212 R211 R210 R209 R208 R414 R422 R421 R420 R419 R418 R417 R416 R415	220
14	11		R223 R222 R221 R220 R219 R218 R217 R216 R243 R242 R400	4.7K
15	16		R408 R407 R406 R405 R404 R403 R402 R401 R430 R429 R428 R427 R426 R425 R424 R423	560
16	2		R411 R410	3.3K
17	1		U3	74LS163
18	1		U7	27512
19	1		CN4	7PKK156 (PIN5=KEY)
20	1		RESET	DO NOT STUFF
21	5		U37 U36 U21 U17 U210	27C040
22	2		U24 U23	74LS165
23	4		C76 C78 C79 C77	25V 10uF RADIAL LYTIC
24	5		C59 C101 C108 C115 C40	25V 22uF RADIAL LYTIC
25	3		C100 C107 C114	35V 10uF RADIAL LYTIC
26	4		C102 C104 C109 C112	25V 100uF RADIAL LYTIC
27	1		C409	16V 22uF RADILA LYTIC
28	1		U35	TDA1899
29	1		C30	16V 1000uF RADIAL LYTIC
30	1		U34	74LS04
31	1		U18	74ALS139
32	6		U16 U12 U13 U15 U211U5	74LS374
33	1		U2	74HC4020
34	1		U10	74LS240
35	6		W2 W3 W1 W4 W5 W6	0
36	2		C81 C31	25V 470uF RADIAL LYTIC
37	2		C10 C35	16V 10uF RADIAL TANT.
38	2		C116 C119	25V 220uF RADIAL LYTIC
39	1		CN2	6PKK156 (PIN 5=KEY)
40	1		X1	24MHZ
41	1		U9	TMS32010
42	3		U19 U20 U213	PAL16L8
43	5		U27 U1 U25 U8 U215	74LS74
44	3		C29 C37 C51	102 (0.001uF)
45	81		C2 C12 C13 C14 C15 C20 C1 C42 C24 C32 C28 C43 C16 C103 C23 C27 C52 C36 C21 C26 C39 C47 C105 C120 C44 C46 C34 C25 C4 C19 C8 C41 C49 C3 C33 C9 C38 C18 C106 C45 C7 C118 C110 C122 C124 C113 C123 C5 C117 C111 C125 C290 C289 C288 C287 C286 C285 C284 C283 C282 C281 C280 C279 C278 C277 C276 C275 C273 C272 C255 C274 C292 C291 C407 C406 C405 C404 C400 C403 C401 C402	104 (0.1uF)
46	1		C121	101 (100pF)
47	4		C48 C50 C75 C80	222 (0.0022uF)
48	48		C270 C269 C268 C267 C271 C265 C266 C262 C261 C260 C259 C263 C256 C257 C258 C249 C248 C247 C254 C250 C251 C252 C220 C219 C218 C217 C216 C215 C213 C212 C211 C210 C209 C208 C200 C201 C202 C203 C205 C206 C207 C230 C229 C253 C214 C204 C264 C408	471 (470pF)
49	8		C221 C222 C223 C225 C226 C227 C228 C224	103 (0.01uF)
50	1		CN3	6PKK156
51	1		U30	LM833
52	2		U22 U11	74LS273
53	9		D1 D100 D2 D103 D104 D101 D105 D102 D3	1N4004
54	2		D201 D200	1N5817
55	9		D407 D406 D405 D404 D403 D402 D401 D400 D202	1N4148
56	6		FB6 FB4 FB5 FB2 FB1 FB3	FB
57	1		VR1	7905
58	3		U102 U100 U101	TDA2030V
59	1		U26	TDA1543
60	1		SW200	B3F4000

THIS PARTS LIST IS CONTINUED ON THE NEXT PAGE.

CPU/Sound Board Parts Continued

ITEM	QTY	PART NUMBER	REF-DESIGNATOR	DESCRIPTION
61	1	Note:	L200	RED LED
62	1		L201	RED LED
63	2	Part Numbers	U217 U216	HCT74
64	1	are not yet	U214	74LS138
65	1	available.	U212	MS6264A
66	1		U209 U6	68B09E
67	1		BAT1 BATTERY HOLDER	3-AA CELLS 4.5V
68	1		CN1	20 PIN 0.1 HEADER
69	10		6MHZ AOR Q AOL 24MHZ	TEST POINTS - DO NOT STUFF
70	10		Q9 Q3 Q4 Q5 Q6 Q7 Q8 Q1 Q2 Q10	2N3904
71	1		CN5	9PKK156 (PIN 2=KEY)
72	2		U201 U203	HCT273
73	7		U207 U206 U202 U200 U205 U208 U204	HC245
74	1		U218	DS1232
75	1		CN8	26 PIN 0.1 HEADER
76	1		CN7	10PKK156 (PIN 4=KEY)
77	4		VBATT +5V GND2 GND1	TEST POINT LOOPS
78	1		CN6	12PKK156 (PIN 5=KEY)
79	1		SW300	8 PIN DIPSWITCH
80	2		U401 U400	LM339AN
81	1		U4	6264
82	3		U100 U101 U102	AAVID 531102

Your Notes

Appendixes A through H

Appendix
Table of Contents

- Appendix A, Pinball Game Firmware Table 126-127
  ...describes the EPROM with its chip size, the Sega Pinball Inc. Part N°, version (if applicable), and CPU Board & CPU/Sound Board pin location(s).

- Appendix B, Semi-Conductors / Integrated Circuits / Relay Cross-Reference Table 128
  ...describes diodes and transistors with Source N°, Sega Pinball Inc. Part N°, NTE N°, ECG N°, Radio Shack Part N° (If applicable) and RCA Part N° (If applicable).

- Appendix C, CPU Jumper Table 129
  ...provides the Game Manufactured Date and Manual Part N°, the CPU version, the ROM Position, and the Jumpers Installed and Removed.

- Appendix D, Board Type Table 130-131
  ...provides Part N° for Flipper Boards, Old Board System (Sound, Power Supply) and New Board System (I/O Power Driver, CU/Sound, Display Power Supply) and Display Boards.

- Appendix E, Generic Coil Cross-Reference Guide and Flipper Coil Table 132-133
  ...provides the Coils used with Part N° and Gauge-Turns (of the coil).

- Appendix F, Motor Specification Table 134-135
  ...provides all the Motor information used on the games (Motor Type, Function and Part N°).

- Appendix G, Part Number Prefix Classification Codes 136
  ...explains how our Part Numbers are developed to help sort parts easier.

- Appendix H, Playfield Inserts (Plastic Light Covers) 137
  ...gives a pictoral view with the name and part number of all the inserts used (also gives the Color Code Chart).

- Glossary of Terms 138-139
  ...gives definitions or explanations of some pinball terms and acronyms.

APPENDIX A
Pinball Game Firmware Table

EPROM	Chip Size	Part Nº	Ver.	Loc.	Raw Part Nº
Laser War					
CPU	(256K)	965-0004-00		C5	960-5007-00
Sound (Old)	(256K)	965-0005-00		J5	960-5007-00
Sound (Old)	(256K)	965-0006-00		J6	960-5007-00
Sound (Old)	(256K)	965-0007-00		J7	960-5007-00
		- OR -			
Sound	(256K)	965-0008-00		7F	960-5007-00
Sound 1	(512K)	965-0009-00		6F	960-7001-02
Sound 2	(512K)	965-0010-00		4F	960-7001-02
Secret Service					
CPU	(256K)	965-0011-00	A-6	B5	960-5007-00
CPU	(256K)	965-0012-00	A-6	C5	960-5007-00
Voice 1	(512K)	965-0014-00		6F	960-7001-02
Voice 2	(512K)	965-0015-00		4F	960-7001-02
Sound	(256K)	965-0013-00		7F	960-5007-00
Torpedo Alley					
CPU	(256K)	965-0016-00	A02-1	B5	960-5007-00
CPU	(256K)	965-0017-00	A02-1	C5	960-5007-00
Voice 1	(512K)	965-0019-00		6F	960-7001-02
Voice 2	(512K)	965-0020-00		4F	960-7001-02
Sound	(256K)	965-0018-00		7F	960-5007-00
Time Machine					
CPU	(256K)	965-0021-00	A02-3	B5	960-5007-00
CPU	(256K)	965-0022-00	A02-3	C5	960-5007-00
Voice 1	(512K)	965-0024-00		6F	960-7001-02
Voice 2	(512K)	965-0025-00		4F	960-7001-02
Sound	(256K)	965-0023-00		7F	960-5007-00
Playboy 35th Anniversary					
CPU	(256K)	965-0046-00	A02-3	B5	960-5007-00
CPU	(256K)	965-0047-00	A02-3	C5	960-5007-00
Voice 1	(512K)	965-0049-00		6F	960-7001-02
Voice 2	(512K)	965-0050-00		4F	960-7001-02
Sound	(256K)	965-0048-00		7F	960-5007-00
ABC Monday Night Football					
CPU	(256K)	965-0031-00	A02-7	B5	960-5007-00
CPU	(256K)	965-0032-00	A02-7	C5	960-5007-00
Voice 1	(512K)	965-0034-00		6F	960-7001-02
Voice 2	(512K)	965-0035-00		4F	960-7001-02
Sound	(256K)	965-0033-00		7F	960-5007-00
Robocop					
CPU	(256K)	965-0036-00	A03-4	B5	960-5007-00
CPU	(256K)	965-0037-00	A03-4	C5	960-5007-00
Voice 1	(512K)	965-0039-00		6F	960-7001-02
Voice 2	(512K)	965-0040-00		4F	960-7001-02
Sound	(256K)	965-0038-00		7F	960-5007-00
Phantom of the Opera					
CPU	(256K)	965-0026-00	A03-2	B5	960-5007-00
CPU	(256K)	965-0027-00	A03-2	C5	960-5007-00
Voice 1	(512K)	965-0029-00		6F	960-7001-02
Voice 2	(512K)	965-0030-00		4F	960-7001-02
Sound	(256K)	965-0028-00		7F	960-5007-00
Back to the Future					
CPU	(256K)	965-0041-00	SA-2	B5	960-5007-00
CPU	(256K)	965-0042-00	SA-2	C5	960-5007-00
Voice 1	(512K)	965-0044-00		6F	960-7001-02
Voice 2	(512K)	965-0045-00		4F	960-7001-02
Sound	(256K)	965-0043-00		7F	960-5007-00
The Simpsons					
CPU	(256K)	965-0051-00	A02-7	B5	960-5007-00
CPU	(256K)	965-0052-00	A02-7	C5	960-5007-00
Voice 1	(512K)	965-0054-00		6F	960-7001-02
Voice 2	(512K)	965-0055-00		4F	960-7001-02
Sound	(256K)	965-0053-00		7F	960-5007-00
Checkpoint					
CPU	(256K)	965-0056-00	A1-7	B5	960-5007-00
CPU	(256K)	965-0134-00	A1-7	C5	960-5007-00
Voice 1	(1M)	965-0057-00		F7	960-5009-00
Voice 2	(1M)	965-0058-00		F5	960-5009-00
Sound	(256K)	965-0059-00		F4	960-5007-00
Display	(512K)	965-0060-00	CP80	U8	960-7001-02

EPROM	Chip Size	Part Nº	Ver.	Loc.	Raw Part Nº
Teenage Mutant Ninja Turtles					
CPU	(256K)	965-0061-00	A1.04	B5	960-5007-00
CPU	(256K)	965-0062-00	A1.04	C5	960-5007-00
Voice 1	(1M)	965-0063-00		F5/6	960-5009-00
Voice 2	(1M)	965-0064-00		F4/5	960-5009-00
Sound	(256K)	965-0065-00		F7	960-5007-00
Display	(512K)	965-0066-00		U8	960-7001-02
Batman					
CPU	(128K)	965-0067-00	A1.06	B5	960-5006-00
CPU	(256K)	965-0135-00	A1.06	C5	960-5007-00
Voice 1	(2M)	965-0068-00		U17	960-5010-00
Voice 2	(1M)	965-0069-00		U21	960-5009-00
Sound	(256K)	965-0070-00		U7	960-5007-00
Display	(1M)	965-0071-00	A1.02	U8	960-5009-00
Star Trek 25th Anniversary					
CPU	(512K)	965-0072-00	A2.00	B5	960-7001-02
Voice 1	(2M)	965-0073-00		U17	960-5010-00
Voice 2	(2M)	965-0074-00		U21	960-5010-00
Sound	(256K)	965-0075-00		U7	960-5007-00
Display	(1M)	965-0076-00	A1.09	U8	960-5009-00
Hook					
CPU	(512K)	965-0077-00	A4.08	C5	960-7001-02
Voice 1	(2M)	965-0078-00		U17	960-5010-00
Voice 2	(2M)	965-0079-00		U21	960-5010-00
Sound	(256K)	965-0080-00		U7	960-5007-00
Display	(1M)	965-0081-00	A4.01	U8	960-5009-00
Lethal Weapon 3					
CPU	(512K)	965-0082-00	A2.07	C5	960-7001-02
Voice 1	(2M)	965-0083-00		U17	960-5010-00
Voice 2	(2M)	965-0084-00		U21	960-5010-00
Sound	(256K)	965-0085-00		U7	960-5007-00
Display	(2M)	965-0086-00		ROM 1	960-5010-00
Display	(2M)	965-0087-00		ROM 2	960-5010-00
Display	(4M)	965-0087-04	A2.06	ROM 0	960-5015-00
Star Wars					
CPU	(512K)	965-0119-00	A1.03	C5	960-7001-02
Voice 0	(4M)	965-0132-00		U17	960-5015-00
Voice 1	(2M)	965-0133-00		U21	960-5010-00
Sound	(256K)	965-0131-00		U7	960-5007-00
Display	(2M)	965-0120-00	A1.04	ROM 0	960-5010-00
Display	(2M)	965-0121-00	A1.04	ROM 1	960-5010-00
	(Used on Display PCB 520-5055-00)				
	-OR-				
Display	(4M)	965-0122-00	A1.05	ROM 0	960-5015-00
	(Used on Display PCB 520-5055-01)				
Rocky & Bullwinkle & Friends					
CPU	(512K)	965-0138-00	A1.30	C5	960-7001-02
Voice 0	(4M)	965-0139-00		U17	960-5015-00
Voice 1	(2M)	965-0140-00		U21	960-5010-00
Sound	(256K)	965-0141-00		U7	960-5007-00
Display	(4M)	965-0142-00	A1.30	ROM 0	960-5015-00
Jurassic Park					
CPU	(512K)	965-0143-00	A5.10	C5	960-7001-02
Voice 0	(4M)	965-0144-00		U17	960-5015-00
Voice 1	(2M)	965-0145-00		U21	960-5010-00
Sound	(256K)	965-0146-00		U7	960-5007-00
Display	(4M)	965-0147-00	A5.10	ROM 0	960-5015-00
Last Action Hero					
CPU	(512K)	965-0148-00	A1.12	C5	960-7001-02
Voice 0	(4M)	965-0149-00		U17	960-5015-00
Voice 1	(2M)	965-0150-00		U21	960-5010-00
Sound	(256K)	965-0151-00		U7	960-5007-00
Display	(4M)	965-0152-00	A1.06	ROM 0	960-5015-00
Tales from the Crypt					
CPU	(512K)	965-0157-00	A3.00	C5	960-7001-02
Voice 0	(4M)	965-0158-00		U17	960-5015-00
Voice 1	(2M)	965-0159-00		U21	960-5010-00
Sound	(256K)	965-0160-00		U7	960-5007-00
Display	(4M)	965-0161-00	A3.00	ROM 0	960-5015-00

Table Notes:
Game Revisions can be updated after the production run. This table is accurate as of the printing of this manual. To see if any changes occurred, the next game manual will include updates. The version stated is USA. If there is a question of what revision number any particular ROM is and the next game manual(s) are not available, call our Technical Support Department.

Table continued on the next page.

APPENDIX A
Pinball Game Firmware Table

EPROM	Chip Size	Part Nº	Ver.	Loc.	Raw Part Nº
The Who's Tommy					
CPU	(512K)	965-0162-00	A4.00	C5	960-7001-02
Voice 1	(4M)	965-0165-00		U17	960-5015-00
Voice 2	(4M)	965-0166-00		U21	960-5015-00
Voice 3	(4M)	965-0167-00		U36	960-5015-00
Voice 4	(4M)	965-0168-00		U37	960-5015-00
Sound	(512K)	965-0164-00		U7	960-7001-02
Display	(4M)	965-0163-00	A4.00	ROM 0	960-5015-00
WWF Royal Rumble					
CPU	(512K)	965-0169-00	A1.06	C5	960-7001-02
Voice 1	(4M)	965-0172-00		U17	960-5015-00
Voice 2	(4M)	965-0173-00		U21	960-5015-00
Voice 3	(4M)	965-0174-00		U36	960-5015-00
Sound	(512K)	965-0171-00		U7	960-7001-02
Display	(4M)	965-0170-00	A1.02	ROM 0	960-5015-00
Guns N' Roses					
CPU	(512K)	965-0175-00	A3.00	C5	960-7001-02
Voice 1	(4M)	965-0178-00		U17	960-5015-00
Voice 2	(4M)	965-0179-00		U21	960-5015-00
Voice 3	(4M)	965-0180-00		U36	960-5015-00
Voice 4	(4M)	965-0181-00		U37	960-5015-00
Sound	(512K)	965-0177-00		U7	960-7001-02
Display	(4M)	965-0176-00	A3.00	ROM 0	960-5015-00
Maverick					
CPU	(512K)	965-0182-00	A4.04	C5	960-7001-02
Voice 1	(4M)	965-0186-00		U17	960-5015-00
Voice 2	(4M)	965-0187-00		U21	960-5015-00
Voice 3	(4M)	965-0187-01		U36	960-5015-00
Sound	(512K)	965-0185-00		U7	960-7001-02
Display*	(4M)	965-0183-00	A4.01	ROM 0	960-5015-00
Display*	(4M)	965-0184-00	A4.01	ROM 3	960-5015-00
Mary Shelley's Frankenstein					
CPU	(512K)	965-0188-00	A1.03	C5	960-7001-02
Voice 1	(4M)	965-0192-00		U17	960-5015-00
Voice 2	(4M)	965-0193-00		U21	960-5015-00
Voice 3	(4M)	965-0194-00		U36	960-5015-00
Sound	(512K)	965-0191-00		U7	960-7001-02
Display*	(4M)	965-0189-00	A1.03	ROM 0	960-5015-00
Display*	(4M)	965-0190-00	A1.03	ROM 3	960-5015-00
Baywatch					
CPU	(512K)	965-0195-00	A4.01	C5	960-7001-02
Voice 1	(4M)	965-0196-00		U17	960-5015-00
Voice 2	(4M)	965-0197-00		U21	960-5015-00
Voice 3	(Correction Note: 2M/U36 was not used in this game.)				
Sound	(512K)	965-0199-00		U7	960-7001-02
Display*	(4M)	965-0200-00	A4.01	ROM 0	960-5015-00
Display*	(4M)	965-0201-00	A4.01	ROM 3	960-5015-00
Batman Forever					
CPU	(512K)	965-0202-00	A3.02	C5	960-7001-02
Voice 1	(4M)	965-0203-00		U17	960-5015-00
Voice 2	(4M)	965-0204-00		U21	960-5015-00
Sound	(512K)	965-0205-00		U7	960-7001-02
Display*	(4M)	965-0206-00	A3.00	ROM 0	960-5015-00
Display*	(4M)	965-0207-00	A3.00	ROM 3	960-5015-00

New Board System

ROM	Chip Size	Part Nº	Ver.	Loc.	Raw Part Nº
Apollo 13					
CPU / Sound Board:					
Game ROM	(1M)	965-0208-00	IN PRODUCTION	U210	960-5009-00
Voice 1	(4M)	965-0209-00		U17	n/a (masked)
Voice 2	(4M)	965-0210-00		U21	n/a (masked)
Voice 3	(4M)	965-0211-00		U36	n/a (masked)
Sound	(512K)	965-0212-00		U7	960-7001-02
Display Controller Board:					
Display	(4M)	965-0213-00		ROM 0	960-5015-00

*** Note: Display EPROMS (4M) for Maverick thru Batman Forever require an access time of 120 Nsec or faster.**

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APPENDIX B
Semi-Conductors / Integrated Circuits / Relays Cross-Reference Table

Table 1 Diodes	Source Nº	SEGA PINBALL™ Part Nº	NTE Nº	ECG Nº	Radio Shack® Part Nº	RCA® Part Nº
Rectification, Blocking and/or Dampening						
Diode	1N4001	112-5001-00	NTE552	ECG552	- — - — -	SK9000
Diode	1N4004	112-5003-00	NTE116	ECG116	276-1103	SK3312
Diode	1N5401	112-0056-00	NTE5801	ECG5801	276-1143	SK9004
Diode	1N5404	112-5004-00	NTE5804	ECG5804	276-1144	SK9007

Table 2 Diodes	Source Nº	SEGA PINBALL™ Part Nº	NTE Nº	ECG Nº	Radio Shack® Part Nº	RCA® Part Nº
Zener						
Diode	1N4742A 12v	112-0061-00	NTE142A	ECG142A	276-563	SK12V
Diode	1N4760B 68v	112-0062-00	NTE5092A	ECG5092A	- — - — -	SK68V
Diode	1N4764 100v	112-0049-00	NTE5096A	ECG5096A	- — - — -	SK100V
Diode	1N5228 3.9v	112-0053-00	NTE5007A	ECG5007A	- — - — -	SK3A9
Diode	1N5234B 6.2v	112-0047-00	NTE5013A	ECG5013A	276-561	SK6A2
Diode	1N5379 110v	112-0072-00	NTE5157	ECG5157	- — - — -	SK110X

Table 3 Bridge Rectifiers	Source Nº	SEGA PINBALL™ Part Nº	Comments
Bridge Rectifier	CM3501	112-0052-00	35 Amp @ 100v P.I.V.
Bridge Rectifier	MDA2501	112-0054-00	25 Amp @ 100v P.I.V.
Bridge Rectifier	MDA3502	112-0057-00	35 Amp @ 200v P.I.V.

Table 4 Transistors	Source Nº	SEGA PINBALL™ Part Nº	NTE Nº	ECG Nº	Radio Shack® Part Nº	RCA® Part Nº
Transistor	2N4401	- — - — -	NTE85	ECG85	276-2009	SK3124A
Transistor	2N5060, SCR	110-0074-00	NTE5400	ECG5400	276-1067	SK3950
Transistor	2N5401	110-0078-00	NTE288	ECG288	- — - — -	SK3434
Transistor	2N6427	110-0070-00	NTE48	ECG48	- — - — -	SK4906
Transistor	MJE15031	110-0103-00	NTE375	ECG375	- — - — -	SK9118
Transistor	MJE340	110-0071-00	NTE157	ECG157	- — - — -	SK3747
Transistor	MJE350	110-0072-00	NTE374	ECG374	- — - — -	SK9042
Transistor	MPSA92	110-0100-00	NTE288	ECG278	- — - — -	SK3434
Transistor	MPSA42	110-0082-00	NTE287	ECG287	- — - — -	SK3232
Transistor	NPN, 2N3904	110-0069-00	NTE85	ECG85	276-2009	SK3124A
Transistor	NPN, TIP122	110-0067-00	NTE261	ECG261	276-2068	SK3896
Transistor	PNP, TIP42	110-0068-00	NTE332	ECG332	- — - — -	SK9236
Transistor	TIP32C	110-0071-00	NTE292	ECG292	- — - — -	SK3441
Transistor	TIP36C	110-0077-00	NTE393	ECG393	- — - — -	SK3961

Table 5 Relays	Source Nº	SEGA PINBALL™ Part Nº	Comments
PPB Relay	FRL264 P024/02CK	190-5002-00	24v DC 10 Amp DPDT
Power Supply Relay	FRL264 P024/02CK	190-5003-00	24v DC 10 Amp DPDT
CPU Relay	- — - — -	190-5001-00	6v DC 5 Amp 4 Pole

APPENDIX C
CPU Jumper Table

Game Name	Game Mfg. Date and Manual PN	CPU Ver.	EPROM Position	Jumpers Installed	Jumpers Removed
1. Laser War	MAY 87 780-5001-00	1 2	5C 5B, 5C	J4 J6a J7a J4 J5a J6a	J5 J6 J7b J5 J5b J6b
2. Secret Service	MAR 88 780-5002-00	2	5B, 5C	J4	J5
3. Torpedo Alley	AUG 88 780-5003-00	2	5B, 5C	J4	J5
4. Time Machine	DEC 88 780-5004-00	2	5B, 5C	J4	J5
5. Playboy 35th Anniversary	MAY 89 780-5005-00	2	5B, 5C	J4	J5
6. ABC Monday Night Football	SEP 89 780-5007-00	2	5B, 5C	J4	J5
7. Robocop	NOV 89 780-5006-00	2	5B, 5C	J4	J5
8. Phantom of the Opera	JAN 90 780-5008-00	2	5B, 5C	J4	J5
9. Back to the Future	JUN 90 780-5009-00	3	5B, 5C	J4	J5
10. The Simpsons	SEP 90 780-5012-00	3	5B, 5C	J4	J5
11. Checkpoint	FEB 91 780-5010-00	3	5B, 5C	J4	J5
12. Teenage Mutant Ninja Turtles	MAY 91 780-5017-00	3	5B, 5C	J4	J5
13. Batman	JUL 91 780-5011-00	3	5B, 5C	J4	J5
14. Star Trek 25th Anniversary	OCT 91 780-5014-00	3	5C	J5	J4
15. Hook	JAN 92 780-5019-00	3	5C	J5	J4
16. Lethal Weapon 3	JUN 92 780-5026-00	3	5C	J5	J4
17. Star Wars	OCT 92 780-5024-00	3	5C	J5	J4
18. Rocky & Bullwinkle & Friends	FEB 93 780-5022-00	3	5C	J5	J4
19. Jurassic Park	APR 93 780-5020-00	3	5C	J5	J4
20. Last Action Hero	AUG 93 780-5027-00	3	5C	J5	J4
21. Tales from the Crypt	NOV 93 780-5018-00	3	5C	J5	J4
22. The Who's Tommy	FEB 94 780-5028-00	3	5C	J5	J4
23. WWF Royal Rumble	MAY 94 780-5023-00	3	5C	J5	J4
24. Guns N' Roses	JUL 94 780-5029-00	3	5C	J5	J4
25. Maverick	SEP 94 780-5031-00	3	5C	J5	J4
26. Mary Shelley's Frankenstein	DEC 94 780-5036-00	3	5C	J5	J4
27. Baywatch	MAR 95 780-5033-00	3	5C	J5	J4
28. Batman Forever	JUL 95 780-5038-00	3	5C	J5	J4

Game Name	Game Mfg. Date and Manual PN	CPU Ver.	ROM Position	Jumpers Installed	Jumpers Removed
29. Apollo 13	NOV 95 780-5044-00	—	U210	n / a	n / a

† Additional Information for Installed / Removed Jumpers (List 1-28 only):

Board Combinations with **ROM** at Location **5C** (Game 1, Ver1) **Installed** J1b, J3, J4, J6a, **J7a** & J8 **Removed** J1a, J2, J5, **J6** & **J7b**

Board Combinations w/ **ROM** at Locations **5B**, **5C** (Game 1, Ver2) **Installed** J1b, J3, J4, **J5a, J6a, J7b** & J8 **Removed** J1a, J2, J5, **J5b, J6b,** & **J7a**

Board Combinations w/ **ROM** at Locations **5B**, **5C** (Games 2-12, Ver2/3) **Installed** J1b, J3, **J4**, **J5b, J6b,** J7b & J8 **Removed** J1a, J2, **J5, J5a, J6a** & J7a

Board Combinations with **ROM** at Locations **5C** (Games 14+, Ver3) **Installed** J1b, J3, **J5**, J5b, J6b, J7b & J8 **Removed** J1a, J2, **J4,** J5a, J6a & J7a

* Version 1 has a 2K RAM which is a 24-pin IC in Position 5D; Versions 2 & 3 have a 8K RAM which is a 28-PIN IC in Position 5D.

APPENDIX D
Board Type Table

Game Name	Flipper	Sound	Power Supply	Display X-Digit
Laser War	NO FLIPPER BOARD (NFB) 2-Flipper	*initial:* 520-5002-00 *replaced with:* 520-5002-02 520-5002-01 was not used.	520-5000-00	Master: 520-5004-00 plus: 7 Digit Alpha/Numeric 520-5005-00 (Qty. 2) 7 Digit Numeric 520-5006-00 (Qty. 2) 4 Digit Numeric 520-5007-00
Secret Service	NFB 3-Flipper	520-5002-02	520-5000-00	520-5014-01 7 Digit Alpha/Numeric Combined
Torpedo Alley	NFB 3-Flipper	520-5002-02	520-5000-00	520-5014-01 7 Digit Alpha/Numeric Combined
Time Machine	NFB 2-Flipper	520-5002-02	520-5000-00	520-5014-01 7 Digit Alpha/Numeric Combined
Playboy 35th Anniversary	520-5033-00 2-Flip. (for 100 games)	520-5002-02	520-5000-00	520-5014-01 7 Digit Alpha/Numeric Combined
ABC Monday Night Football	520-5033-00 2-Flip. (for 100 games)	520-5002-02	520-5000-00	520-5030-00 16 Digit Alpha/Numeric Combined
Robocop	520-5033-00 2-Flipper	520-5002-02	520-5000-00	520-5030-00 16 Digit Alpha/Numeric Combined
Phantom of the Opera	520-5033-00 2-Flipper	520-5002-02	520-5000-00	520-5030-00 16 Digit Alpha/Numeric Combined
Back to the Future	520-5033-00 2-Flipper	520-5002-02	520-5000-00	520-5030-00 16 Digit Alpha/Numeric Combined
The Simpsons	520-5033-00 2-Flipper	520-5002-03	520-5000-00	520-5030-00 16 Digit Alpha/Numeric Combined

Game Name	Flipper	Sound	Power Supply	Dot Matrix Display	Display Controller
Checkpoint	520-5033-00 2-Flipper	520-5002-03	520-5047-00	520-5042-00 128 X 16	Not Used
Teenage Mutant Ninja Turtles	520-5033-00 2-Flipper	520-5002-03	520-5047-00	520-5042-00 128 X 16	Not Used
Batman	520-5033-00 2-Flipper	520-5050-01	520-5047-00	520-5042-00 128 X 16	Not Used
Star Trek 25th Anniversary	520-5033-00 2-Flipper	520-5050-01	520-5047-00	520-5042-00 128 X 16	Not Used
Hook	520-5033-00 2-Flipper	520-5050-01	520-5047-00	520-5042-00 128 X 16	Not Used
Lethal Weapon 3	520-5033-00 2-Flipper	520-5050-01	520-5047-01	520-5052-00 128 X 32	520-5055-00
Star Wars	520-5033-00 2-Flipper	520-5050-02	520-5047-01	520-5052-00 128 X 32	520-5055-00
Rocky & Bullwinkle & Friends	520-5033-00 2-Flipper	520-5050-02	520-5047-01	520-5052-00 128 X 32	520-5055-00
Jurassic Park	520-5076-00 3-Flipper	520-5050-02	520-5047-02	520-5052-00 128 X 32	520-5055-00
Last Action Hero	520-5070-00 2-Flipper	520-5050-03	520-5047-02	520-5052-00 128 X 32	520-5055-00
Tales from the Crypt	520-5076-00 3-Flipper	520-5050-03	520-5047-02	520-5052-00 128 X 32	520-5055-01
The Who's Tommy	520-5076-00 3-Flipper	520-5077-00	520-5047-02	520-5052-00 128 X 32	520-5055-01
WWF Royal Rumble	520-5070-00 (Qty. 2) 4-Flipper (2X2)	520-5077-00	520-5047-02	520-5052-00 128 X 32	520-5055-01

Table continued on the next page.

APPENDIX D
Board Type Table

Game Name	Flipper	Sound	Power Supply	Dot Matrix Display	Display Controller
Guns N' Roses	520-5076-00 3-Flipper	520-5077-00	520-5047-02	520-5052-00 128 X 32	520-5055-01
Maverick	520-5076-00 3-Flipper	520-5050-03	520-5047-03	520-5075-00 192 X 64	520-5092-01
Mary Shelley's Frankenstein	520-5076-00 3-Flipper	520-5077-00	520-5047-03	520-5075-00 192 X 64	520-5092-01
Baywatch	520-5080-00 (Qty. 2) 4-Flipper (2X2)	520-5126-02	520-5047-03	520-5075-00 192 X 64	520-5092-01
Batman Forever	520-5076-00 3-Flipper	520-5126-02	520-5047-03	520-5075-00 192 X 64	520-5092-01

NEW BOARD SYSTEM

Game Name	Flipper	I/O Power Driver	CPU / Sound	Display Power Supply	Dot Matrix Display	Display Controller
Apollo 13	520-5070-00 2-Flipper	520-5137-00	520-5136-00	520-5138-00	520-5052-00 128 X 32	520-5055-01

APPENDIX E
Generic Coil Cross-Reference Guide

SEGA PINBALL™ Part Nº	Gauge-Turns	SEGA PINBALL™ Part Nº	Gauge-Turns	SEGA PINBALL™ Part Nº	Gauge-Turns	SEGA PINBALL™ Part Nº	Gauge-Turns
090-5000-00	22-700	090-5011-00	22-750	090-5020-00	Not Used	090-5030-00	23-1100
090-5001-00	23-800	090-5012-00	26-800	090-5020-01	21-900	090-5032-00	22-1080
090-5001-01	23-800	090-5013-00	23-700	090-5020-02	22-900	090-5034-00	25-1240
090-5002-00	24-900	090-5014-00	23-600	090-5020-10	21-900	090-5036-00	24-940
090-5003-00	27-1300	090-5015-00	27-1400	090-5020-20	22-900	090-5036-01	24-940
090-5004-00	27-1500	090-5016-00	29-2000	090-5020-30	23-900	090-5037-03	23½-765
090-5005-00	23-840	090-5017-00	22-500	090-5021-00	20-400		
090-5006-00	23-800	090-5018-00	23-800	090-5022-00	23-700	090-5041-00	25-1800
090-5008-00	23-1200	090-5019-00	23-750	090-5023-00	22-600	090-5046-00	28-1050
				090-5025-00	24-1570		

Flipper Coil Table

Game Name	Flipper: **Lower Right** SEGA PINBALL™ Part Nº w/Ga.-Turns	Flipper: **Lower Left** SEGA PINBALL™ Part Nº w/Ga.-Turns	Flipper: **Upper Right** SEGA PINBALL™ Part Nº w/Ga.-Turns	Flipper: **Upper Left** SEGA PINBALL™ Part Nº w/Ga.-Turns
Laser Wars	090-5011-00 22-750/30-2600	SAME AS LOWER RIGHT	Not Used	Not Used
Secret Service	090-5006-00 23-620/30-2600	SAME AS LOWER RIGHT	SAME AS LOWER RIGHT	Not Used
Torpedo Alley	090-5013-00 23-700/30-2600	090-5011-00 22-750/30-2600	090-5012-00 26-800	Not Used
Time Machine	090-5011-00 22-750/30-2600	SAME AS LOWER RIGHT	Not Used	Not Used
Playboy 35th Anniversary †	090-5020-02 22-900	SAME AS LOWER RIGHT	Not Used	Not Used
ABC Monday Night Football †	090-5020-02 22-900	SAME AS LOWER RIGHT	Not Used	Not Used
Robocop	090-5020-20 22-900	SAME AS LOWER RIGHT	Not Used	Not Used
Phantom of the Opera	090-5020-20 22-900	SAME AS LOWER RIGHT	Not Used	Not Used
Back to the Future	090-5020-20 22-900	SAME AS LOWER RIGHT	Not Used	Not Used
The Simpsons	090-5020-20 22-900	SAME AS LOWER RIGHT	Not Used	Not Used
Checkpoint	090-5020-20 22-900	SAME AS LOWER RIGHT	Not Used	Not Used
Teenage Mutant Ninja Turtles	090-5020-30 23-900	SAME AS LOWER RIGHT	Not Used	Not Used
Batman	090-5020-30 23-900	SAME AS LOWER RIGHT	Not Used	Not Used
Star Trek 25th Anniversary	090-5020-30 23-900	SAME AS LOWER RIGHT	Not Used	Not Used
Hook	090-5020-30 23-900	090-5030-00 23-1100	Not Used	Not Used
Lethal Weapon 3	090-5030-00 23-1100	SAME AS LOWER RIGHT	Not Used	Not Used
Star Wars	090-5032-00 22-1080	SAME AS LOWER RIGHT	Not Used	Not Used

† A very small % of these games used a 090-5020-20 coil which used a proto-type Solid State Flipper System. The two types of coils both are 22-900 coils; the only difference being the addition of the 1N5404 Diode on the (-02) coils which was used in the Deger Design.

Table continued on the next page.

APPENDIX E
Flipper Coil Table

Game Name	Flipper: **Lower Right** SEGA PINBALL™ Part Nº w/Ga.-Turns	Flipper: **Lower Left** SEGA PINBALL™ Part Nº w/Ga.-Turns	Flipper: **Upper Right** SEGA PINBALL™ Part Nº w/Ga.-Turns	Flipper: **Upper Left** SEGA PINBALL™ Part Nº w/Ga.-Turns
Rocky & Bullwinkle & Friends	090-5020-30 23-900	**SAME AS LOWER RIGHT**	Not Used	Not Used
Jurassic Park	090-5020-30 23-900	**SAME AS LOWER RIGHT**	090-5030-00 23-1100	Not Used
Last Action Hero	090-5020-30 23-900	**SAME AS LOWER RIGHT**	Not Used	Not Used
Tales from the Crypt	090-5032-00 22-1080	**SAME AS LOWER RIGHT**	090-5041-00 25-1800	Not Used
The Who's Tommy	090-5020-30 23-900	**SAME AS LOWER RIGHT**	Not Used	090-5041-00 25-1800
WWF Royal Rumble	090-5032-00 22-1080	**SAME AS LOWER RIGHT**	090-5041-00 25-1800	**SAME AS UPPER RIGHT**
Guns N' Roses	090-5032-00 22-1080	**SAME AS LOWER RIGHT**	Not Used	090-5030-00 23-1100
Maverick	090-5032-00 22-1080	**SAME AS LOWER RIGHT**	090-5032-00 22-1080	Not Used
Mary Shelley's Frankenstein	090-5030-00 23-1100	**SAME AS LOWER RIGHT**	090-5030-00 23-1100	Not Used
Baywatch	090-5020-30 23-900	090-5030-00 23-1100	**SAME AS LOWER LEFT**	090-5025-00 24-1570
Batman Forever	090-5020-20 22-900	090-5032-00 22-1080	090-5020-30 23-900	Not Used
Apollo 13	090-5032-00 22-1080	**SAME AS LOWER RIGHT**	Not Used	Not Used

APPENDIX F
Motor Specification Table

Game Name	Function	Specifications	Part Nº
Laser Wars Secret Service Torpedo Alley Time Machine Playboy 35th Anniversary	No motors were used on the games listed on the shaded lines.		
ABC Monday Night Football	Goal Post Up/Down	Motor 24v A.C. 60 RPM CW	515-5222-00
Robocop			
Phantom of the Opera	Organ Up/Down	Bowman Motor 24v 60hz 3W 11 RPM CCW	515-5256-00
Back to the Future The Simpsons			
Checkpoint	Shaker	Johnson Motor (Vibrator)	041-5002-00
	Mag Wheel (in Backbox)	Motor D.C. (KEN)	041-5005-00
Teenage Mutant Ninja Turtles	Spinning Pizza Ball Deflector	Gear Motor 24v A.C. 325 RPM CW	515-5397-00
Batman	Bar Target Up/Down	Bowman Motor 24v 60hz 3W 11 RPM CCW	515-5256-00
Star Trek 25th Anniversary	Swinging Target	Bowman Motor 24v 22½ RPM	515-5534-00
	Transporter F/X	Gear Motor 24v A.C. 3.5 RPM	500-5421-00
	Cooling Fan for Transporter F/X	4½" Motor 12v	041-5014-00
Hook			
Lethal Weapon 3	Spinning Light	Motor 2.5v A.C. 4000 RPM CCW	041-5017-00
Star Wars	Bar Target Up/Down	Bowman Motor 24v 60hz 3W 11 RPM CCW	515-5256-00
	R2D2 Robot Movement	Bowman Motor 24v A.C. 22½ RPM CW	515-5571-00
	Death Star Rotation	Bowman "G" Motor 24v A.C. 60hz 6 RPM CW	515-5570-00
Rocky & Bullwinkle & Friends	Nell Log "Cutting Blade" Movement	Bowman Model E Motor 24v 11 RPM CCW	041-5023-00
Jurassic Park	Shaker	Johnson Motor Vibrator	041-5002-00
	T-Rex Left/Right Movement	Multi Motor 5v D.C.	041-5025-00
	T-Rex Up/Down Movement	Bowman Motor 24v 11 RPM CW	041-5026-00

Table Continued on the next page.

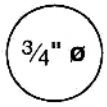
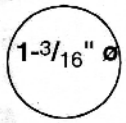
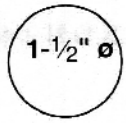
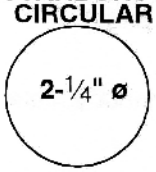
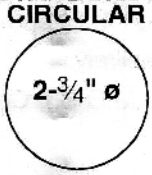
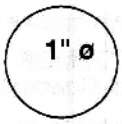
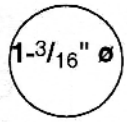
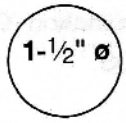
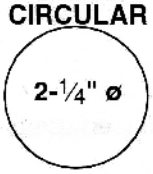
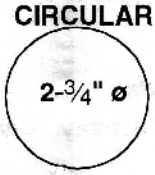
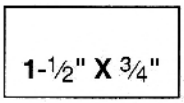
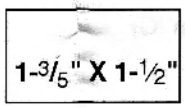
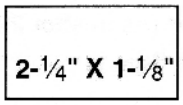
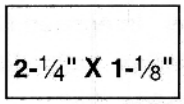
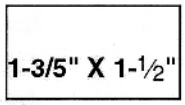
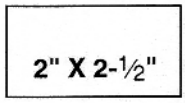
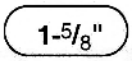
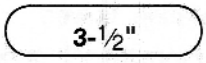
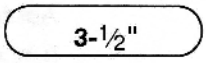
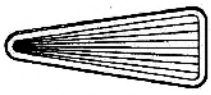
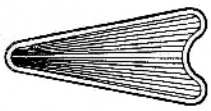
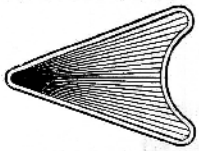
APPENDIX F
Motor Specification Table

Game Name	Function	Specifications	Part Nº
Last Action Hero	Crane Left/Right Movement	Multi Prod. #3312 Motor OSC 12v D.C.	041-5027-00
	Shaker	Motor Vibrator	041-5029-00
Tales from the Crypt	Shaker	Motor Vibrator	041-5029-00
	Tombstone Up/Down	Bowman Motor 24v A.C. 6 RPM CCW	515-5900-00
The Who's Tommy	Mirror Up/Down	Bowman Motor 24v A.C. 6 RPM CCW	515-5900-00
	Flipper Blinders	Servo Motor	041-5032-00
	Spinning Airplane Propellers	Motor D.C.	041-5033-00
WWF Royal Rumble	Shaker	Motor Vibrator	041-5029-00
Guns N' Roses			
Maverick, The Movie	Turning Paddle Wheel	Motor 24v A.C. 10 RPM	041-5036-00
Mary Shelley's Frankenstein	Creature Head Left/Right Movement	Servo Motor	041-5032-00
Baywatch			
Batman Forever	Cannon Left/Right Movement	Bowman Motor 24v A.C. 60Hz 3W 6 RPM CCW	515-6383-00
Apollo 13	Rocket Up/Down Movement	Bowman Motor 24v A.C. 60Hz 3W 6 RPM CCW	515-6383-00
	Moon Unit Up/Down Movement	Multi Motor 24v A.C. 50/60Hz 3W 6 RPM CCW	515-6487-00
	Shaker	Motor Vibrator	041-5029-00

APPENDIX G
Part Number Prefix Classification Codes

I.	**ELECTRICAL SOURCE AND ENERGY AND SIGNAL CONVERTERS**	
	010-	Transformers
	031-	Speakers
	090-	Solenoids
II.	**CONDUCTORS, CONNECTORS AND INSULATORS**	
	034-	Line Cords
	036-	Cable and Harness Assemblies
	041-	Motors
	045-	Connectors (All Types)
	077-	Lamp Sockets
III.	**CIRCUITS AND CIRCUIT ELEMENTS**	
	100-	ICs
	110-	Transistors
	112-	Diodes
	121-	Resistors
	123-	Resistors (Variable & Adjustable)
	125-	CAPS
	140-	Crystals
	165-	Light Bulbs
	180-	Switches
	190-	Relays
IV.	**BOLTS, SCREWS, NUTS, AND WASHERS**	
	231-	Bolts
	232-	Screws (Pan Head)
	234-	Screws (HXW)
	237-	Screws (Misc.)
	240-	Nuts (Misc.)
	242-	Washers (Flat, Round)
	244-	Washers (Split Lock)
	246-	Washers (Lockers, External Tooth)
V.	**MECHANICAL COMPONENTS**	
	249-	Rivets
	251-	Pins (Dowel)
	254-	Stand-Offs, Spacers and Shims
	260-	Steel Ball
	265-	Springs (Extension)
	266-	Springs (Compression)
	269-	Springs (Washers - Belleville, Wave)
	280-	Grommets and Bushing
VI.	**HANDLES, LOCKS, CATCHES & LATCHES, KEYS & HINGES**	
	355-	Handles, Locks, Catches & Latches and Keys
	390-	Hinges
VII.	**FABRICATED PARTS (IN-HOUSE ASSEMBLIES)**	
	500-	End Product (Systems and Models)
	515-	Sub-Assemblies
	520-	P.C. Boards
	522-	Display Glass
	525-	Wood Parts
	530-	Screw Machined Parts
	535-	Fabricated Parts
	545-	Molded (Extruded) Parts (Rubber Rings, Molded Plastic)
	550-	Molded (Inserts)
VIII.	**BULK MATERIALS**	
	600-	Braided Ground Wire
	601-	Stranded Wire
	602-	Ribbon Cable
	605-	Sleeving (Shrink Tubing)
	626-	Foam Rubber
IX.	**MISCELLANEOUS**	
	705-	Packing & Shipping Items
	820-	Decals and Labels (Sets & Misc.)
	820-	Butyrate
	900-	Game Posters
	960-	EPROM (Raw Part)
	965-	EPROM (Programmed Part)

APPENDIX H
Playfield Inserts (Plastic Light Covers)

Patterns: STARBURST STIPPLE	STARBURST CIRCULAR 5/8" ø 550-5000-XX	STARBURST CIRCULAR  3/4" ø 550-5001-XX	STARBURST CIRCULAR 1" ø 550-5002-XX	STARBURST CIRCULAR  1-3/16" ø 550-5003-XX	STARBURST CIRCULAR  1-1/2" ø 550-5004-XX
STARBURST CIRCULAR  2-1/4" ø 550-5005-XX	STARBURST CIRCULAR  2-3/4" ø 550-5006-XX	PLAIN CIRCULAR 3/4" ø 550-5007-XX	PLAIN CIRCULAR  1" ø 550-5008-XX	PLAIN CIRCULAR  1-3/16" ø 550-5009-XX	PLAIN CIRCULAR  1-1/2" ø 550-5010-XX
PLAIN CIRCULAR  2-1/4" ø 550-5011-XX	PLAIN CIRCULAR  2-3/4" ø 550-5012-XX	STIPPLE CIRCULAR 1" ø 550-5048-XX	STIPPLE 1" SQUARE 1" 550-5019-XX	ROLLOVER BUTTON BASE 550-5026-XX	WHITE STAR *(only in white)* 545-5015-00
STIPPLE RECTANGULAR  1-1/2" X 3/4" 550-5018-XX	STIPPLE RECTANGULAR  1-3/5" X 1-1/2" 550-5051-XX	STARBURST RECTANGULAR  2-1/4" X 1-1/8" 550-5044-XX	PLAIN RECTANGULAR  2-1/4" X 1-1/8" 550-5049-XX	PLAIN RECTANGULAR  1-3/5" X 1-1/2" 550-5050-XX	PLAIN RECTANGULAR  2" X 2-1/2" 550-5063-XX
STARBURST MINI SHIELD 1" X 1" 550-5024-XX	STARBURST LARGE SHIELD 2-1/5" X 2" 550-5025-XX	MINI HOT DOG  1-5/8" 550-5020-XX	BEVEL HOT DOG  3-1/2" 550-5021-XX	PLAIN HOT DOG  3-1/2" 550-5022-XX	BANANA 550-5023-XX
STARBURST ARROW-SHORT  550-5013-XX	STARBURST ARROW-LARGE  550-5014-XX	STARBURST ARROW-HEAD  550-5015-XX	STARBURST BULLET 550-5016-XX	STARBURST TRIANGLE 550-5017-XX	

Note: The shapes and sizes shown above are not to scale. Some shapes may no longer be available in every color.

Plastic Part Color Chart (As applicable for all parts which can come in various colors.):
The "-XX" should be replaced with the following 2-digit number for the color desired.

-01:	CLEAR	-06:	YELLOW	-11	FLUORESCENT GREEN
-02:	RED	-07:	ORANGE	-12	FLUORESCENT BLUE
-03:	AMBER	-08:	WHITE	-13	TEAL GREEN
-04:	GREEN	-09:	PURPLE	-14	GRAY
-05:	BLUE	-10	FLUORESCENT ORANGE	-15	*NEW:* LUMINESCENT

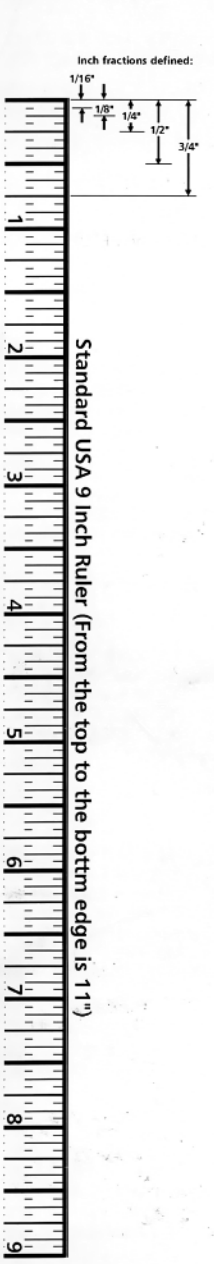
GLOSSARY OF TERMS

A	Followed after a number means "Amp." or Ampage in an expression relating to an electrical object. e.g. 8A (eight amps).
AC	Acronym: Alternating Current.
Adj.	Abbreviation: Adjustment(s).
A.L.I.S.O.N. Interface	See Section 3, Chapter 6.
Au.	Abbreviation: Audit(s).
BOT	Abbreviation: Bottom.
Bridge Rectifier	A configuration of a diode that allows current to flow in one direction producing both positive and negative pulsating DC Voltages.
COLOR CODING	See Appendix H, Color Chart (Bottom) or Section 4, Chapter (last page).
Combination (Combo)	[Shot]. Any variable pinball shot(s) made succesively.
CMOS	Short for COSMOS (Complementary Symmetry M.O.S.); Complementary Metal-Oxide Semi-Conductor.
CT	Abbreviation: Center.
DC	Abbreviation: Direct Current.
DT	Abbreviation: Drop Target(s).
EB	Acronym: Extra Ball.
Eject	Playfield surface device to kick ball back into play.
EPROM	Acronym: Erasable Programmable Read Only Memory. Can be erased using UV Light and re-programmed.
e.g.	Abbreviation: Latin- Exempli gratia. For Example.
EOS	Acronym: End-of-Stroke.
G.I.	Abbreviation: General Illumination (Lamps).
IC	Acronym: Integrated Circuit (As in after 24-Pin IC)
i.e.	Abbreviation: Latin- Id est. That is.
LT	Abbreviation: Left.
Laser Kick	A coil/plunger used above the playfield to kick pinball back into play.
LED	Light emitting diode.
Loop	[Shot] Continuously up a ramp and back to the flipper.
Lwr.	Abbreviation: Lower.
Orbit	[Shot] From the left or right flipper around the back rail of the playfield back to the flipper.
MB	Acronym: Magnet Board.
M-BALL or MBALL	Abbreviation: Multiball™.
MID	Abbreviation: Middle
Non-Reflexive	See Reflexive.
No. or Nº or #	Abbreviation: Number
NPF	Acronym: No Problem Found.
N.C. or NC	Abbreviation: Normally Closed.
N.O. or NO	Abbreviation: Normally Open.
PCB	Acronym: Printed Circuit Board
PIA LED	Acronym: Peripheral Interface Adapter. This is a diagnostic LED on the CPU; it should not be lit during normal operation of a pinball game.
Plumb Bob Tilt	Weight on Tilt Assembly.
Pop(s)	Another term for Turbo Bumper(s).
PPB	Playfield Power Board (Generic Term to describe Acronym with no true definition).
PSB	Acronym: Power Supply Board

GLOSSARY OF TERMS

P/F	Abbreviation: Playfield
RAM	Acronym: Random Access Memory. RAM **can** store input instructions and supply output information.
RED	Abbreviation: Red.
Reflexive/Non-Reflexive (Relating to CPU Boards)	**Reflexive**—Solenoid Drive Transistor is enabled directly by a switch closure on the solenoid assembly (Ver. 1/2). **Non-Reflexive**—Solenoid Drive Transistor is enabled by the CPU after reading a switch closure in the Switch Matrix (Ver. 3). Also note: All CPU Boards are backwards compatible (e.g. Jurassic Park/Ver. 3 to Time Machine/ Ver. 2). Swapping a Ver. 2 Board to a Ver. 3 is not possible due to the special solenoids section (i.e. Slingshots, Turbo Bumpers, etc.) changing from REFLEXIVE to NON-REFLEXIVE on Ver. 3 Boards.
Relay	An automatic switch operated by current in a coil.
ROM	Aconym: Read Only Memory. ROM **cannot** store input instructions but can supply output information. ROM can be programmed only once.
RT	Abbreviation: Right.
RO	Abbreviation: Rollover (switches).
Saucer	See Eject.
Scoop	A hole into the playfield. A metal scoop is in place to guide the ball into the kick-back under the playfield.
Slam Tilt	A switch which closes when the game is slammed into or the Coin Door is slammed shut. Depending on adjustable settings, will cancel game in play when the number of closures required is sufficed.
SMB	Acronym: Shaker Motor Board.
Solenoid	A coil used for Electro Magnetic devices such as relays, flippers, slingshots, etc.
SSFB	Acronym: Solid State Flipper Board.
STEP	Refers to the service switches on the coin door.
S-U	Abbreviation: Stand-Up (targets).
TM	Acronym: Trademark
Transfer	[Shot] Maneuvering the ball in play from one flipper to the other. With flipper in the up position and the ball cradled by that flipper one would activate the flipper button in a quick repetive manner to bounce the ball to the other side. Skilled players can rebound the ball off the slingshot.
TTL	Acronym: Transistor-Transistor Logic
Upr.	Abbreviation: Upper.
V or v	Abbreviation: Volt(s).
Ver.	Abbreviation: Version.
VUK	Acronym: Vertical Up-Kicker.
X	Acronym: "Times" A multiplier.
Zener Diode	A semi-conductor diode used for voltage regulation. Application depends on reverse break-down voltage.

GLOSSARY OF TERMS



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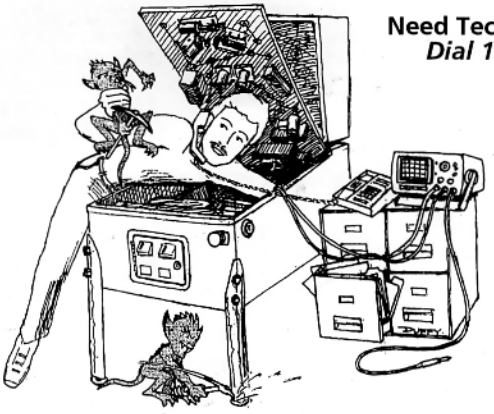

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